This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 50436 2

1817
ARTES VERITAS SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR

Astron.
Obs.
QB
1
.C722

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—No. 25

RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING 59 CYGNI

BY

HAROLD JACOBY

NEW YORK
1908

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—No. 25

RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING 59 CYGNI

BY

HAROLD JACOBY

NEW YORK
1908

Attention is called to the Lists of Errata in former Contributions from the Observatory, to be found in Publication 19, p. 68, and Publication 24, p. 74.

PRESS OF
THE NEW ERA PRINTING COMPANY
LANCASTER, PA.

UNIV. OF MICH.
DEC 11 1908

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—No. 25

RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING 59 CYGNI

BY

HAROLD JACOBY

NEW YORK
1908

Astron. Obs.

PREFATORY NOTE.

The present memoir contains further results derived from the collection of Rutherfurd photographs belonging to Columbia University. The measures were made at Columbia by Miss F. E. Harpham, assisted by Misses H. L. Davis and Eudora Magill, who have also aided in the routine work of reduction. We have again departed to some extent from the methods of our older publications, notably in the formation of a "mean" plate to be used as a standard for the reduction and inter-comparison of the individual photographs.

The expenses connected with this publication have been met by Rutherfurd Stuyvesant, Esq., of New York.

HAROLD JACOBY,
Rutherfurd Professor of Astronomy and
Director of the Observatory.

COLUMBIA UNIVERSITY,
January, 1908.

THE RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING 59 CYGNI.

The present paper contains results derived from twelve negatives made by Rutherfurd in 1875 and 1876, and measured at Columbia University in 1903 and 1904. The computations have been planned in such a way that they fall naturally in two parts : first, an intercomparison of the separate plates ; second, a reduction of mean results derived from the photographs, using the *Astronomische Gesellschaft* Catalog as a standard. Tables appended to the present paper summarize the several steps of the work.

Table I gives in customary form various details inscribed upon the plates by Rutherfurd himself. The "sidereal time" is the mean of the four instants of beginning and ending for two exposures: as usual, Rutherfurd made two complete pictures on each plate. Of the three thermometers used, the first was attached to the mercurial barometer, the second was in the open air, and the third was fastened to the telescope tube. The column "focus" contains readings of a micrometer on the plate end of the telescope, intended to indicate the variations of distance between the plate-holder and object glass.

The measures were made with the usual Repsold machine in rectangular coördinates, both images of each star being observed in direct and reversed positions of the plate. Instrumental corrections were applied to the measures as follows :

1. Screw errors of the microscope.
2. Runs.
3. Division errors of the measuring machine scale.
4. "Rotation corrections" to render the two coördinates perfectly rectangular.

The final coördinates, thus fully corrected for all instrumental errors are set down in Table II.

The coördinates of Table II were next changed from millimeters to seconds of arc approximately with the scale value 1 mm. = $52''.87$. They can be corrected for refraction with the following notation and formulæ:

φ = Latitude of Rutherfurd's observatory.

θ = Sidereal time from Table I.

α and δ = Right ascension and declination of the plate center approximately.

β = The usual refraction constant increased by $\frac{1}{65}$ to allow for the difference between photographic and visual refractions.

If we then compute the auxiliary quantities:

$$\begin{aligned}
\tan N &= \cot\phi\cos(\theta-\alpha)\\
G &= \cot(\delta+N),\\
H &= \tan(\theta-\alpha)\sin N\operatorname{cosec}(\delta+N),\\
M_x &= \beta(1+H^2)\sin 1'',\\
N_x &= \beta(GH-H\tan\delta)\sin 1'',\\
M_y &= \beta(GH+H\tan\delta)\sin 1'',\\
N_y &= \beta(1+G^2)\sin 1'',
\end{aligned}$$

the refraction corrections required by the measured coördinates in Table II, are:

$$\begin{aligned}
&\text{for } X, \quad M_x X + N_x Y,\\
&\text{for } Y, \quad M_y X + N_y Y.
\end{aligned}$$

The refraction coefficients M_x, N_x, M_y, N_y are tabulated in Table III for the various plates.

The next step was an intercomparison of the twelve plates. There are fifteen stars occurring on all the plates; for each of these the X's and Y's from Table II, corrected for refraction, were combined into arithmetical means. This gave us fifteen pairs of mean coördinates belonging to an imaginary mean plate. We then corrected the coördinates of each plate in such a way as to bring about the best possible agreement of that plate with the imaginary mean plate. For this purpose, we let:

p = a correction required by the assumed scale-value $52''.87$ for the plate in question.

r = a small angle through which the coördinate axes of the plate must be rotated.

k, c = corrections of the plate-center in X and Y.

Then for each of the fifteen stars there is a pair of equations of the form:

$$pX + rY + k = x - X,$$
$$pY - rX + c = y - Y,$$

where the right-hand members are the coördinate differences between the mean plate and each individual plate, taken in the sense mean *minus* plate. A least squares solution of these thirty equations for each plate gave results contained in Table IV; and these values of p, r, k and c are suitable for the reduction of each individual plate to the mean plate. This reduction was carried out by simply adding to the measured coördinates of all stars, whether common to all the plates or not, corrections for refraction and corrections based on Table IV. In other words, we corrected the measured coördinates of Table II as follows:

$$\text{for } X,\quad (p + M_x)X + (r + N_x)Y + k,$$
$$\text{for } Y,\quad (-r + M_y)X + (p + N_y)Y + c.$$

Means of these corrected coördinates were then formed for all stars. These means for the fifteen stars common to all plates of course coincided with the mean-plate coördinates already obtained for these fifteen stars, on account of the method by which p, r, k and c were obtained. For the remaining stars this method constitutes a reduction to the mean system of the twelve plates, even though these stars are lacking on certain plates.

Having thus reduced all coördinates to a mean system, Table V was formed. This table gives the arithmetical averages of all coördinates reduced as above, with the differences between each plate and the average, taken in the sense plate *minus* average.

The mean coördinates of Table V were next corrected in such a way as to bring about the best possible agreement with the star places in the *Astronomische Gesellschaft* Catalog. Table VI shows which stars are common to the *Astronomische Gesellschaft* Catalog and to Table V.

Our method of procedure was that published in "Tables for the Reduction of Astronomical Photographs" (Contrib. Col.

Univ. Observatory, 23). In this method, rectangular coördinates x, y, are computed from the *Astronomische Gesellschaft* Catalog places, and then a series of equations are solved, similar to those used in the comparison of each plate with the mean plate. These equations are of the form

$$pX + rY + k + (X - x) = 0,$$
$$pY - rX + c + (Y - y) = 0;$$

in which X, Y, are the mean coördinates of Table V and x, y those computed from the *Astronomische Gesellschaft* Catalog. It will be seen that p, r, k, c, are now plate-constants suitable for bringing about the best possible agreement between the mean of all our photographs and the *Astronomische Gesellschaft* Catalog.

A solution of the eighty available equations of this form gave results and residuals contained in Table VII. The probable error of one equation, and the residuals are much larger than those of Table IV, but they now include of course the rather large errors of the meridian circle places. In these computations no attention was paid to proper motion, the epochs of the plates and the *Astronomische Gesellschaft* Catalog being nearly the same.

With the values of p, r, k, c, from Table VII we next corrected the mean coördinates of Table V, giving the final coördinates of Table VIII. These are now photographic coördinates of all stars, fully corrected, and brought into the best possible general agreement with the *Astronomische Gesellschaft* Catalog.

To determine next the stellar photographic magnitudes, the diameters of all star-images were measured on our best plate; the results are set down in Table IX, in which the quantities are expressed in revolutions of the micrometer screw, equivalent to half-millimeters. A comparison was made with the *Astronomische Gesellschaft* Catalog magnitudes, and two constants a, b, determined, such that the photographic magnitude m can be computed from the diameters D of the star-images by the formula

$$m = a - b \log D.$$

The values of a and b that produce the best possible agreement with the *Astronomische Gesellschaft* magnitudes were found to be:

$$a = 13.73(\pm 0.58),\quad b = +4.51(\pm 0.49),\quad M = 13.73 - 4.51 \log D.$$

We next collected in Table X a final photographic catalog. The right ascensions and declinations were computed from the photographic final coördinates of Table VIII by the formulæ of Contrib., 23, p. 6; the photographic magnitudes by the formula just given, and the precessions with the usual constants.

TABLE I.—PHOTOGRAPHS OF 59 CYGNI.

OBSERVATORY OF L. M. RUTHERFURD, NEW YORK.

Lat. 40° 43′ 48″.5. Long. $4^h\ 55^m\ 56^s.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Z. D.
				Att.	Ext.	Tel.		
		h m s	in.					°
1	1875 Aug. 5	17 55 2	30.050	72°	70°	74°	7.6	32.7
2	1875 Aug. 5	18 27 42	30.050	72	70	74	7.6	27.1
3	1875 Aug. 5	18 58 18	30.050	72	70	74	7.6	21.9
4	1876 July 22	17 41 28	30.056	76	75	77	7.55	35.0
5	1876 July 24	17 6 18	30.010	70	68	70	7.6	40.9
6	1876 Aug. 4	18 25 22	30.246	72	70	74	7.55	27.5
7	1876 Aug. 4	18 58 22	30.246	72	70	74	7.55	21.9
8	1876 Nov. 12	1 41 12	30.018	46	45	48	7.8	50.0
9	1876 Nov. 12	2 17 42	30.018	46	45	48	7.8	55.8
10	1876 Nov. 16	0 52 2	30.280	41	41	42	7.85	42.1
11	1876 Nov. 16	1 21 2	30.280	41	41	42	7.85	46.8
12	1876 Nov. 16	1 50 8	30.280	41	41	42	7.85	51.5

TABLE II. — CORRECTED COÖRDINATES.

PLATE 1.			PLATE 2.			PLATE 3.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
4	−52.0639	− 1.3903	3	−54.1746	−22.7725	3	−54.1589	−22.8208
5	−51.0071	+11.8718	4	−52.0665	− 1.4126	4	−52.0650	− 1.4562
6	−49.4675	− 1.5856	5	−51.0139	+11.8512	5	−51.0279	+11.8096
7	−46.0616	− 6.0969	6	−49.4677	− 1.6079	6	−49.4668	− 1.6448
10	−37.4133	−21.4254	7	−46.0631	− 6.1149	7	−46.0602	− 6.1523
12	−35.6915	+26.7366	8	−45.8032	+11.8922	8	−45.8155	+11.8468
13	−32.9663	+ 4.5386	10	−37.4102	−21.4405	9	−45.7865	−27.8318
15	−27.3361	−22.5021	12	−35.6996	+26.7171	10	−37.3928	−21.4668
16	−19.7620	−18.4478	13	−32.9741	+ 4.5233	11	−36.4020	+20.9932
17	−17.9192	+ 6.8648	15	−27.3338	−22.5198	12	−35.7290	+26.6976
18	−17.4128	−62.2388	16	−19.7626	−18.4610	13	−32.9758	+ 4.5026
19	−15.4827	−47.1012	17	−17.9246	+ 6.8526	15	−27.3142	−22.5374
20	−15.3120	−24.0715	18	−17.3944	−62.2480	16	−19.7482	−18.4739
23	− 5.9319	−12.1517	19	−15.4674	−47.1110	17	−17.9308	+ 6.8422
24	− 5.2282	+53.7215	20	−15.3113	−24.0785	18	−17.3420	−62.2584
25	− 2.7200	+ 0.1179	21	−13.1842	+ 3.3482	19	−15.4295	−47.1240
26	− 1.5684	−47.7160	23	− 5.9311	−12.1633	20	−15.2892	−24.0882
27	− 0.0564	+ 0.3770	24	− 5.2334	+53.7092	21	−13.1924	+ 3.3408
28	0.0000	0.0000	25	− 2.7232	+ 0.1100	22	− 9.6244	+ 8.9264
30	+10.7700	−29.3219	26	− 1.5604	−47.7207	23	− 5.9232	−12.1629
33	+12.8670	+32.9017	27	− 0.0514	+ 0.3738	24	− 5.2900	+53.7124
34	+18.6768	−21.6492	28	0.0000	0.0000	25	− 2.7289	+ 0.1136
35	+20.6590	− 1.6242	30	+10.7778	−29.3280	26	− 1.5181	−47.7200
36	+21.0262	+26.4649	33	+12.8574	+32.8946	27	− 0.0577	+ 0.3769
38	+24.1859	−34.3744	34	+18.6838	−21.6514	28	0.0000	0.0000
39	+26.0568	+ 6.1371	35	+20.6540	− 1.6264	30	+10.8066	−29.3111
40	+31.8452	+34.3744	36	+21.0202	+26.4645	33	+12.8277	+32.9144
41	+37.2932	−23.9619	37	+22.6077	+20.0990	34	+18.7018	−21.6261
42	+42.6353	−37.1362	38	+24.1928	−34.3718	35	+20.6581	− 1.6006
43	+44.8345	−44.9552	39	+26.0596	+ 6.1320	36	+20.9935	+26.4910
44	+46.2166	−28.5481	40	+31.8314	+34.3792	37	+22.5874	+20.1279
46	+58.7006	+23.4200	41	+37.3018	−23.9580	38	+24.2237	−34.3453
			42	+42.6436	−37.1303	39	+26.0478	+ 6.1644
			43	+44.8459	−44.9485	40	+31.7993	+34.4159
			44	+46.2282	−28.5514	41	+37.3182	−23.9179
			46	+58.7004	+23.4256	43	+44.8829	−44.8998
						44	+46.2490	−28.4969
						46	+58.6773	+23.4899

TABLE II. — CORRECTED COÖRDINATES. — *Continued.*

PLATE 4.			PLATE 5.			PLATE 6.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
7	−46.0468	− 6.1790	3	−54.1714	−22.7722	7	−46.0844	− 5.9788
9	−45.7674	−27.8538	4	−52.0579	− 1.4112	9	−45.8962	−27.6558
10	−37.3777	−21.4866	6	−49.4555	− 1.6102	10	−37.4769	−21.3234
14	−28.2108	+53.1690	7	−46.0584	− 6.1170	13	−32.9617	+ 4.6275
17	−17.9298	+ 6.8276	9	−45.8082	−27.7955	14	−27.9961	+53.2994
19	−15.4028	−47.1296	10	−37.4073	−21.4389	15	−27.4024	−22.4326
20	−15.2751	−24.0962	11	−36.3712	+21.0184	16	−19.8216	−18.3971
23	− 5.9083	−12.1659	13	−32.9613	+ 4.5240	17	−17.9051	+ 6.9086
24	− 5.3070	+53.6982	14	−28.1281	+53.2153	19	−15.6137	−47.0584
25	− 2.7251	+ 0.1073	15	−27.3360	−22.5197	21	−13.1785	+ 3.3888
26	− 1.4929	−47.7173	16	−19.7636	−18.4583	22	− 9.5954	+ 8.9610
27	− 0.0568	+ 0.3752	17	−17.9202	+ 6.8488	23	− 5.9734	−12.1402
28	0.0000	0.0000	18	−17.4117	−62.2478	24	− 5.0860	+53.7271
29	+ 9.7945	+17.9224	19	−15.4736	−47.1090	25	− 2.7360	+ 0.1215
30	+10.8198	−29.3072	20	−15.3127	−24.0796	26	− 1.7034	−47.7114
33	+12.8144	+32.9150	23	− 5.9474	−12.1608	27	− 0.0615	+ 0.3760
34	+18.7095	−21.6195	24	− 5.2176	+53.7146	28	0.0000	0.0000
35	+20.6584	− 1.5941	25	− 2.7420	+ 0.1048	30	+10.6867	−29.3529
36	+20.9788	+26.4923	26	− 1.5737	−47.7201	33	+12.9456	+32.8635
37	+22.5758	+20.1337	28	0.0000	0.0000	34	+18.6141	−21.6977
38	+24.2372	−34.3373	30	+10.7789	−29.3224	35	+20.6488	− 1.6802
40	+31.7802	+34.4250	33	+12.8682	+32.8967	36	+21.0892	+26.4080
42	+42.6916	−37.0668	34	+18.6764	−21.6458	37	+22.6591	+20.0389
43	+44.8994	−44.8817	35	+20.6550	− 1.6227	38	+24.0854	−34.4378
44	+46.2531	−28.4777	36	+21.0212	+26.4649	39	+26.0677	+ 6.0644
45	+58.6671	− 1.8228	37	+22.6128	+20.1032	40	+31.9213	+34.2914
46	+58.6616	+23.5128	38	+24.1778	−34.3680	41	+37.2249	−24.0586
			39	+26.0562	+ 6.1350	42	+42.5348	−37.2524
			41	+37.2870	−23.9471	43	+44.7080	−45.0732
			42	+42.6337	−37.1241	44	+46.1273	−28.6749
			43	+44.8236	−44.9431	46	+58.7578	+23.2658
			45	+58.6514	− 1.8988			
			46	+58.6925	+23.4313			

TABLE II. — CORRECTED COÖRDINATES — *Continued.*

Plate 7.			Plate 8.			Plate 9.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
1	−59.4502	+16.1821	1	−59.4653	+16.0748	1	−59.4778	+16.0355
4	−52.0606	− 1.3968	2	−59.0477	−15.1912	2	−59.0382	−15.2329
5	−51.0027	+11.8576	3	−54.0898	−22.8601	3	−54.0722	−22.8958
6	−49.4608	− 1.5946	4	−52.0344	− 1.4929	4	−52.0303	− 1.5302
7	−46.0612	− 6.1007	5	−51.0148	+11.7682	5	−51.0209	+11.7307
9	−45.8073	−27.7812	6	−49.4338	− 1.6846	6	−49.4349	− 1.7186
10	−37.4083	−21.4279	7	−46.0310	− 6.1934	7	−46.0222	− 6.2226
12	−35.6984	+26.7326	8	−45.7978	+11.8160	8	−45.8120	+11.7786
13	−32.9689	+ 4.5316	9	−45.7299	−27.8687	9	−45.7035	−27.8971
14	−28.1368	+53.2228	10	−37.3409	−21.4944	10	−37.3234	−21.5211
15	−27.3361	−22.5070	11	−36.4118	+20.9691	11	−36.4231	+20.9386
17	−17.9186	+ 6.8583	12	−35.7305	+26.6696	12	−35.7644	+26.6475
18	−17.4023	−62.2364	13	−32.9628	+ 4.4732	13	−32.9632	+ 4.4529
19	−15.4745	−47.1035	14	−28.2458	+53.1744	14	−28.2865	+53.1544
21	−13.1834	+ 3.3502	15	−27.2668	−22.5590	15	−27.2480	−22.5755
23	− 5.9346	−12.1525	16	−19.7011	−18.4819	16	−19.6887	−18.4962
24	− 5.2270	+53.7089	17	−17.9190	+ 6.8289	17	−17.9231	+ 6.8174
25	− 2.7240	+ 0.1155	19	−15.3542	−47.1345	19	−15.3172	−47.1371
26	− 1.5618	−47.7156	20	−15.2418	−24.0928	20	−15.2274	−24.1109
27	− 0.0563	+ 0.3783	21	−13.1775	+ 3.3332	21	−13.1805	+ 3.3297
28	0.0000	0.0000	23	− 5.8906	−12.1619	23	− 5.8880	−12.1695
30	+10.7775	−29.3216	24	− 5.3370	+53.7158	24	− 5.3842	+53.7056
32	+12.7050	− 2.0230	25	− 2.7107	+ 0.1190	25	− 2.7172	+ 0.1117
33	+12.8646	+32.8979	26	− 1.4445	−47.7139	26	− 1.4130	−47.7129
34	+18.6848	−21.6435	27	− 0.0426	+ 0.3850	27	− 0.0492	+ 0.3854
35	+20.6635	− 1.6214	28	0.0000	0.0000	28	0.0000	0.0000
36	+21.0243	+26.4678	29	+ 9.7961	+17.9381	30	+10.8693	−29.2892
37	+22.6098	+20.1021	30	+10.8559	−29.2964	33	+12.7652	+32.9338
38	+24.1912	−34.3694	31	+12.1547	+ 6.6036	34	+18.7471	−21.5888
39	+26.0610	+ 6.1359	32	+12.7131	− 1.9994	35	+20.6615	− 1.5679
40	+31.8372	+34.3805	33	+12.7987	+32.9333	36	+20.9410	+26.5253
41	+37.2919	−23.9517	34	+18.7337	−21.6035	37	+22.5420	+20.1675
42	+42.6395	−37.1234	35	+20.6686	− 1.5738	38	+24.2933	−34.3067
43	+44.8391	−44.9458	36	+20.9688	+26.5132	39	+26.0344	+ 6.2067
44	+46.2210	−28.5448	37	+22.5715	+20.1536	40	+31.7243	+34.4645
46	+58.7042	+23.4253	38	+24.2724	−34.3198	41	+37.3576	−23.8573
			39	+26.0487	+ 6.1942	42	+42.7490	−37.0192
			40	+31.7616	+34.4495	43	+44.9644	−44.8262
			41	+37.3541	−23.8755	44	+46.3080	−28.4377
			42	+42.7355	−37.0457	46	+58.6180	+23.5802
			43	+44.9342	−44.8565			
			44	+46.2822	−28.4487			
			46	+58.6478	+23.5530			

TABLE II.—CORRECTED COÖRDINATES—*Concluded.*

PLATE 10.			PLATE 11.			PLATE 12.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
1	—59.4593	+16.1242	1	—59.4709	+16.0868	1	—59.4684	+16.0609
4	—52.0441	— 1.4498	2	—59.0611	—15.1836	2	—59.0480	—15.2081
5	—51.0029	+11.8085	3	—54.0991	—22.8504	3	—54.0832	—22.8751
6	—49.4459	— 1.6458	4	—52.0392	— 1.4822	4	—52.0319	— 1.5084
7	—46.0403	— 6.1502	5	—51.0082	+11.7780	5	—51.0110	+11.7563
8	—45.7913	+11.8508	6	—49.4406	— 1.6757	6	—49.4317	— 1.6995
9	—45.7634	—27.8288	7	—46.0323	— 6.1804	7	—46.0246	— 6.2060
10	—37.3663	—21.4631	8	—45.8009	+11.8219	8	—45.8024	+11.7995
11	—36.3944	+20.9970	9	—45.7370	—27.8585	9	—45.7186	—27.8846
12	—35.7134	+26.6992	10	—37.3468	—21.4868	10	—37.3334	—21.5078
13	—32.9582	+ 4.5037	11	—36.4006	+20.9806	11	—36.4131	+20.9583
14	—28.1935	+53.2038	12	—35.7278	+26.6815	12	—35.7402	+26.6570
15	—27.2932	—22.5324	13	—32.9586	+ 4.4823	13	—32.9575	+ 4.4664
16	—19.7247	—18.4641	14	—28.2329	+53.1812	14	—28.2528	+53.1655
17	—17.9139	+ 6.8453	15	—27.2729	—22.5500	15	—27.2604	—22.5679
19	—15.4025	—47.1150	16	—19.7094	—18.4776	16	—19.6919	—18.4903
20	—15.2657	—24.0829	17	—17.9167	+ 6.8347	17	—17.9191	+ 6.8261
21	—13.1760	+ 3.3490	19	—15.3677	—47.1261	19	—15.3392	—47.1354
23	— 5.9025	—12.1532	20	—15.2506	—24.0938	20	—15.2336	—24.1010
24	— 5.2897	+53.7193	21	—13.1775	+ 3.3409	21	—13.1750	+ 3.3288
25	— 2.7105	+ 0.1214	22	— 9.6190	+ 8.9262	22	— 9.6232	+ 8.9228
26	— 1.4946	—47.7112	23	— 5.8924	—12.1570	23	— 5.8861	—12.1654
27	— 0.0442	+ 0.3862	24	— 5.3282	+53.7235	24	— 5.3528	+53.7136
28	0.0000	0.0000	25	— 2.7108	+ 0.1221	25	— 2.7070	+ 0.1136
30	+10.8242	—29.3036	26	— 1.4555	—47.7132	26	— 1.4325	—47.7162
34	+18.7186	—21.6172	27	— 0.0439	+ 0.3879	27	— 0.0442	+ 0.3919
35	+20.6726	— 1.5910	28	0.0000	0.0000	28	0.0000	0.0000
37	+22.5908	+20.1364	29	+ 9.7965	+17.9392	29	+ 9.7912	+17.9401
38	+24.2437	—34.3364	30	+10.8443	—29.2952	30	+10.8612	—29.2938
39	+26.0569	+ 6.1736	31	+12.1514	+ 6.6042	31	+12.1528	+ 6.6050
40	+31.8051	+34.4289	32	+12.7136	— 1.9953	32	+12.7124	— 1.9920
41	+37.3380	—23.9121	33	+12.8052	+32.9308	33	+12.7913	+32.9344
43	+44.8970	—44.8924	34	+18.7314	—21.6043	34	+18.7472	—21.5988
44	+46.2621	—28.4905	35	+20.6717	— 1.5789	35	+20.6705	— 1.5729
46	+58.6828	+23.5019	36	+20.9760	+26.5120	36	+20.9631	+26.5176
			37	+22.5719	+20.1515	37	+22.5615	+20.1595
			38	+24.2678	—34.3204	38	+24.2837	—34.3123
			39	+26.0509	+ 6.1910	39	+26.0451	+ 6.1986
			40	+31.7713	+34.4472	40	+31.7486	+34.4536
			41	+37.3499	—23.8774	41	+37.3603	—23.8709
			42	+42.7251	—37.0538	42	+42.7393	—37.0275
			43	+44.9291	—44.8635	43	+44.9432	—44.8340
			44	+46.2750	—28.4576	44	+46.2918	—28.4416
			45	+58.6816	— 1.7908	45	+58.6768	— 1.7734
			46	+58.6576	+23.5434	46	+58.6414	+23.5620

TABLE III. — REFRACTION COEFFICIENTS.

Plate.	M_x	N_x	M_y	N_y
1	+0.000388	+0.000178	−0.000200	+0.000277
2	+ .000348	+ .000151	− .000152	+ .000276
3	+ .000320	+ .000123	− .000114	+ .000277
4	+ .000404	+ .000185	− .000221	+ .000276
5	+ .000473	+ .000206	− .000295	+ .000287
6	+ .000353	+ .000154	− .000156	+ .000278
7	+ .000322	+ .000124	− .000115	+ .000278
8	+ .000652	− .000213	+ .000483	+ .000340
9	+ .000801	− .000171	+ .000655	+ .000404
10	+ .000521	− .000222	+ .000333	+ .000308
11	+ .000598	− .000224	+ .000418	+ .000326
12	+ .000696	− .000210	+ .000528	+ .000358

TABLE IV. — PLATE CONSTANTS.

Plate.	*p*	*r*	Probable Error of *p* or *r*.	*k*	*c*	Probable Error of *k* or *c*.	Probable Error of One Equation.
				″	″	″	″
1	−0.000001	−0.001201	±0.000013	+0.181	+0.010	±0.027	±0.1005
2	+ .000023	− .000942	.000013	+ .192	+ .369	.027	.0979
3	+ .000006	+ .000036	.000007	+ .331	+ .055	.016	.0584
4	+ .000092	+ .000398	.000010	+ .157	+ .262	.021	.0788
5	+ .000046	− .001113	.000027	+ .366	+ .276	.057	.2097
6	+ .000055	− .003832	.000012	+ .516	+ .112	.026	.0977
7	+ .000068	− .001025	.000010	+ .088	+ .076	.020	.0743
8	− .000069	+ .001574	.000013	− .380	− .221	.028	.1015
9	− .000056	+ .002333	.000009	− .175	− .098	.019	.0687
10	− .000041	+ .000579	.000013	− .420	− .310	.027	.1000
11	− .000075	+ .001333	.000014	− .412	− .367	.029	.1072
12	− .000050	+ .001868	.000016	− .439	− .176	.033	.1221

TABLE V.—MEAN *X* AND RESIDUALS FOR EACH PLATE.

Star.	X_m	1	2	3	4	5	6	7	8	9	10	11	12
	″	″	″	″	″	″	″	″	″	″	″	″	″
1	—3145.17							+.13	+.19	—.11	—.07	—.17	+.02
2	—3125.47								+.33	—.13		—.02	—.19
3	—2863.81		—.32	—.36		—.26			+.39	+.08		+.34	+.13
4	—2753.31	—.12	—.22	+.05		+.02		—.04	+.16	+.07	—.03	+.06	+.03
5	—2698.18	—.07	—.23	—.12				+.15	—.07	—.14	+.17	+.25	+.08
6	—2615.84	—.25	—.23	.00		+.22		.00	+.25	—.11	—.06	+.04	+.11
7	—2435.80	+.10	—.01	+.08	+.07	+.09	+.06	—.02	—.11	—.09	—.06	+.01	—.07
8	—2422.54		—.29	—.09					+.27	—.17	+.19	+.06	.00
9	—2421.51			+.09	—.11	+.07	—.11	+.15	—.03	.00	—.11	+.09	—.07
10	—1977.42	—.05	—.11	—.03	—.23	+.06	—.11	—.03	+.14	+.04	+.09	+.19	+.02
11	—1924.87			+.18		+.28			—.21	—.04	—.24	+.18	—.13
12	—1889.01	.00	—.06	—.05				—.28	+.38	—.39	+.01	+.24	+.11
13	—1743.71	+.04	—.28	+.08		+.30	—.07	—.17	—.11	—.02	+.04	+.13	+.07
14	—1490.57				+.13	+.49	—.02	—.05	—.21	—.15	—.16	—.17	+.10
15	—1444.50	+.08	—.05	+.07		—.05	+.03	—.16	+.06	+.07	—.03	+.10	—.11
16	—1044.10	+.06	—.18	—.16		—.08	—.20		+.18	+.09	—.01	+.03	+.26
17	— 947.89	—.06	—.23	—.03	—.16	—.01	+.06	—.09	+.06	+.20	+.04	+.12	+.05
18	— 917.41	—.01	+.22	+.05		—.28		+.04					
19	— 816.05	—.11	+.15	—.04	.00	+.16	—.11	—.08	+.03	+.07	+.02	—.04	—.02
20	— 808.49	+.11	—.12	+.02	—.08	+.01			+.08	—.12	+.13	—.05	+.02
21	— 697.25		—.01	—.10			+.08	—.10	+.01	+.08	—.06	—.01	+.09
22	— 508.71			+.11			—.03					—.01	—.06
23	— 313.01	+.11	+.01	—.02	+.26	—.65	—.06	—.21	+.14	—.08	+.14	+.19	+.11
24	— 278.92	—.32	+.07	—.07	+.02	+.72	—.01	—.01	+.08	+.01	—.30	—.20	.00
25	— 143.95	+.25	+.10	—.05	—.04	—.74	—.28	—.05	+.20	+.03	+.17	+.15	+.32
26	— 80.32	+.13	—.03	—.04	+.04	—.27	+.01	+.08	+.10	—.07	—.06	+.12	—.08
27	— 2.74	—.08	+.19	+.02	—.09		—.06	—.17	+.14	.00	—.01	+.03	—.01
28	0.00	+.18	+.19	+.33	+.16	+.37	+.52	+.09	—.38	—.18	—.42	—.41	—.44
29	+ 518.98				—.17				+.15			—.13	+.14
30	+ 571.58	—.19	—.12	+.03	—.01	+.37	—.12	—.06	+.21	—.02	.00	—.07	+.02
31	+ 642.98								+.11			—.22	+.10
32	+ 672.02							+.14	—.01			—.03	—.10
33	+ 679.01	—.07	—.18	+.02	.00	+.47	—.17	—.07	+.04	—.03		—.13	+.16
34	+ 989.26	—.09	+.01	—.02	—.11	+.07	—.02	+.12	—.16	.00	+.04	—.09	+.21
35	+1092.92	.00	—.28	—.06	—.06	+.12	+.04	+.14	—.02	—.09	+.12	+.06	+.07
36	+1110.83	+.01	.00	+.01	—.15	+.24	—.01	—.02	—.03	—.01		—.11	+.09
37	+1195.03		+.03	+.06	—.08	+.54	+.07	—.05	+.10	—.21	—.12	—.26	—.10
38	+1281.19	+.07	.00	—.02	—.04	—.23	—.06	+.02	—.01	+.05	+.11	+.10	+.06
39	+1378.08	—.08	+.13	—.10		+.30	+.02	+.11	—.02	—.08	—.09	—.10	—.09
40	+1682.34	+.29	—.04	+.06	—.07		—.12	.00	—.02	—.07	+.24	—.10	—.13
41	+1973.91	+.02	+.16	—.13		—.01	+.17	—.29	+.05	—.25	+.23	.00	+.08
42	+2257.35	—.16	—.20		—.11	+.01	+.14	—.26	+.35	+.06		+.13	+.05
43	+2373.69	+.24	+.26	.00	+.09	—.13	+.21	+.10	—.23	+.06	—.11	—.09	—.38
44	+2446.09	+.05	+.28	—.02	—.20		—.24	+.01	—.15	+.60	.00	—.33	+.01
45	+3103.40				—.03	—.43						+.20	+.24
46	+3103.86	—.25	—.01	—.06	.00	+.07	—.12	+.01	—.04	+.08	+.21	—.05	+.13

TABLE V.—MEAN *Y* AND RESIDUALS FOR EACH PLATE.

Star.	Y_m	1	2	3	4	5	6	7	8	9	10	11	12
	″	″	″	″	″	″	″	″	″	″	″	″	″
1	+ 853.25							—.18	+.06	+.03	—.07	—.02	+.18
2	— 800.36								+.17	—.14		—.11	+.06
3	—1206.23		.00	—.17		—.20			+.19	+.01		+.08	+.10
4	— 76.36	+.08	—.14	—.19		—.24		+.06	+.19	—.05	+.06	+.13	+.10
5	+ 624.98	+.16	+.02	+.02				—.22	+.09	—.13	—.14	—.02	+.20
6	— 86.63	+.17	—.11	+.09		—.39		—.01	+.18	+.03	—.07	+.04	+.07
7	— 325.01	+.15	+.06	+.07	—.02	—.22	—.06	+.21	—.09	—.09	+.06	+.03	—.10
8	+ 627.09		+.30	—.16					+.21	—.18	—.08	—.06	.00
9	—1471.49			+.01	+.08	—.25	+.03	+.07	+.09	+.01	+.08	+.08	—.16
10	—1134.96	—.08	—.13	+.05	+.04	—.24	+.05	—.04	+.18	—.03	+.08	+.11	—.03
11	+1110.65			—.09		—.33			+.17	—.11	—.08	+.26	+.16
12	+1412.18	—.11	—.35	+.05				+.02	+.06	+.23	—.06	+.18	—.04
13	+ 238.28	+.02	—.07	+.15		—.16	+.16	—.12	—.04	+.04	+.01	—.02	+.08
14	+2813.52				—.26	—.03	+.03	+.07	—.02	+.14	+.17	—.12	+.03
15	—1191.66	+.20	—.09	+.04		—.26	+.04	+.06	.00	—.01	+.09	+.09	—.12
16	— 976.65	.00	—.13	—.14		—.13	—.06		+.17	+.07	+.14	+.07	—.01
17	+ 361.98	+.12	+.04	+.07	—.02	—.26	+.02	—.04	—.03	+.09	—.06	—.04	+.13
18	—3292.41	+.02	+.02	+.07		—.20		+.07					
19	—2491.84	+.10	+.05	—.14	—.05	—.03	+.13	—.06	—.16	+.11	+.10	+.04	—.05
20	—1273.74	—.07	+.05	+.01	+.06	—.15			+.26	—.19	+.03	—.05	+.03
21	+ 176.87		+.02	—.04			—.09	—.23	—.05	+.30	+.10	+.07	—.08
22	+ 472.23			—.03			—.05					—.08	+.17
23	— 643.06	+.12	—.08	—.07	+.07	—.07	—.03	+.13	.00	—.14	+.12	+.07	—.08
24	+2840.71	+.07	—.11	—.04	—.21	+.18	—.14	—.32	+.09	+.07	—.06	+.25	+.20
25	+ 6.06	+.04	+.02	+.03	—.04	—.36	—.04	.00	+.16	—.01	+.08	+.16	—.04
26	—2523.51	+.01	+.07	—.10	+.08	—.08	—.01	—.08	+.06	+.09	+.05	—.01	—.09
27	+ 20.14	—.19	.00	—.15	—.03		—.15	—.05	.00	+.15	—.02	+.01	+.41
28	0.00	+.01	+.37	+.06	+.26	+.28	+.11	+.08	—.22	—.10	—.31	—.37	—.18
29	+ 947.87				—.02				—.01			—.02	+.04
30	—1550.14	+.05	—.08	—.02	.00	+.09	—.06	—.04	—.02	+.03	—.01	+.03	—.03
31	+ 348.29								+.01			.00	—.01
32	— 106.48							+.17	—.21			—.03	+.05
33	+1740.64	+.04	—.07	—.02	+.06	+.03	+.06	—.03	+.05	—.05		—.14	+.05
34	—1143.77	—.14	—.13	—.02	—.03	+.06	—.02	+.06	—.02	+.22	+.01	—.01	—.02
35	— 84.75	—.04	—.04	+.01	+.03	+.10	+.01	+.07	+.11	—.09	+.02	—.11	—.07
36	+1400.80	—.09	+.05	+.06	—.06	+.06	+.06	+.12	—.10	+.12		—.14	—.05
37	+1064.35		—.09	—.02	+.03	+.12	—.03	—.01	—.06	+.18	—.06	—.13	+.03
38	—1816.52	—.06	+.12	+.03	—.09	+.20	.00	+.01	—.08	—.15	+.04	+.01	—.02
39	+ 325.84	+.11	—.08	.00		+.04	+.07	+.01	+.02	+.01	.00	—.07	—.05
40	+1819.84	—.27	+.03	+.04	+.10		+.06	+.10	—.05	+.02	+.19	—.07	—.15
41	—1265.07	—.17	—.04	—.08		+.46	+.01	+.17	+.06	—.12	—.30	+.17	—.20
42	—1961.61	—.05	+.09		+.03	+.33	—.20	+.35	—.22	—.17		—.35	+.16
43	—2374.89	—.16	—.01	+.06	—.08	+.17	—.10	+.02	—.12	+.04	—.10	—.17	+.44
44	—1507.54	+.24	—.12	+.16	+.12		+.07	+.16	+.16	—.69	—.06	.00	—.09
45	— 97.93				—.14	+.33						+.02	—.20
46	+1241.85	—.18	—.15	.00	+.06	+.18	+.13	—.03	+.14	—.03	—.05	+.01	—.07

TABLE VI. — CONCORDANCE WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Photo. No. of Star.	No. in A. G. Cat.	Photo. No. of Star.	No. in A. G. Cat.	Photo. No. of Star.	No. in A. G. Cat.	Photo. No. of Star.	No. in A. G. Cat.
1	14840	12	14886	23	14941	36	14986
2	14842	13	14893	24	14943	37	14989
3	14848	14	14900	25	14946	38	14991
4	14855	15	14901	26	14952	39	14995
5	14857	17	14920	27	14954	40	15006
6	14858	18	14924	28	14955	41	15016
7	14865	19	14925	30	14969	42	15024
8	14866	20	14926	33	14975	43	15026
9	14868	21	14930	34	14981	44	15030
10	14883	22	14933	35	14984	46	15052

TABLE VII. — COMPARISON WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

$p = +0.000557 \quad \pm 0.000045$
$r = +0.000102 \quad \pm 0.000045$
$k = +0''.502 \quad \pm 0''.104$
$c = -1''.767 \quad \pm 0''.104$
Probable error of a single equation $= \pm 0.6452$

RESIDUALS.

Star.	v_x	v_y	Star.	v_x	v_y
1	+0″.22	−0″.60	24	−0″.90	+0″.67
2	−1.61	−0.87	25	−0.30	−0.54
3	+0.40	+0.72	26	−1.20	−0.06
4	+0.09	+0.78	27	+0.62	−1.02
5	+0.39	−0.55	28	+0.50	−1.77
6	+1.79	+0.29	30	+0.46	+1.76
7	−0.57	−0.41	33	−0.12	−0.89
8	−0.88	+1.16	34	−1.45	+1.11
9	0.00	−0.05	35	+0.42	−0.08
10	+1.56	+0.87	36	+0.36	+0.02
12	+0.02	+0.85	37	−0.36	−1.03
13	−0.97	+0.20	38	+0.94	−0.88
14	−0.56	−0.94	39	+1.80	+1.87
15	+0.34	−0.60	40	+0.53	+0.56
17	−0.51	+0.57	41	−0.17	−1.07
18	+0.79	+0.83	42	−1.24	+0.02
19	+0.24	+0.22	43	+0.58	−1.35
20	+1.57	−1.70	44	−0.73	+0.25
21	−1.12	+2.11	46	+0.26	+0.44
22	+0.45	−1.80			
23	−1.63	+0.90			

TABLE VIII. — FINAL COÖRDINATES.

Star.	*X*	*Y*	Star.	*X*	*Y*
1	—3146″.33	+ 852″.28	24	— 278″.29	+2840″.55
2	—3126.79	— 802.26	25	— 143.53	+ 4.30
3	—2865.03	—1208.38	26	— 80.12	—2526.68
4	—2754.35	— 77.89	27	— 2.24	+ 18.38
5	—2699.12	+ 623.84	28	+ 0.50	— 1.77
6	—2616.81	— 88.18	29	+ 519.87	+ 946.58
7	—2436.69	— 326.71	30	+ 572.24	—1552.83
8	—2423.33	+ 625.92	31	+ 643.88	+ 346.64
9	—2422.51	—1473.83	32	+ 672.88	— 108.38
10	—1978.14	—1137.16	33	+ 680.07	+1739.77
11	—1925.33	+1109.70	34	+ 990.19	—1146.28
12	—1889.42	+1411.39	35	+1094.02	— 86.68
13	—1744.16	+ 236.82	36	+1112.09	+1399.70
14	—1490.61	+2813.47	37	+1196.31	+1063.05
15	—1444.92	—1193.94	38	+1282.21	—1819.43
16	—1044.28	— 978.85	39	+1379.38	+ 324.11
17	— 947.88	+ 360.51	40	+1683.97	+1818.91
18	— 917.76	—3295.92	41	+1975.38	—1267.74
19	— 816.25	—2494.92	42	+2258.91	—1964.70
20	— 808.57	—1276.14	43	+2375.27	—2378.22
21	— 697.12	+ 175.27	44	+2447.80	—1510.40
22	— 508.44	+ 470.77	45	+3105.62	— 100.07
23	— 312.75	— 645.16	46	+3106.22	+1240.45

TABLE IX.—DIAMETERS OF STAR-IMAGES.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r
1	0.178	17	0.178	33	0.107
2	0.169	18	0.165	34	0.142
3	0.157	19	0.152	35	0.135
4	0.153	20	0.117	36	0.119
5	0.146	21	0.106	37	0.101
6	0.146	22	0.112	38	0.197
7	0.257	23	0.111	39	0.107
8	0.140	24	0.188	40	0.127
9	0.170	25	0.125	41	0.145
10	0.136	26	0.156	42	0.188
11	0.152	27	0.106	43	0.307
12	0.135	28	0.379	44	0.158
13	0.171	29	0.122	45	0.159
14	0.203	30	0.108	46	0.164
15	0.146	31	0.108		
16	0.110	32	0.112		

TABLE X.—FINAL CATALOG.

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	8.1	6	20 50 25.475	312 36 22.12	+2.0072	+30.1083	+0.0026	+0.0389	47 15 49.39	+13.5758	+0.2096	1876.91
2	8.2	4	50 30.027	312 37 30.40	2.0245	30.3677	0.0027	0.0408	46 48 15.59	13.5807	0.2114	76.96
3	8.3	7	50 56.099	312 44 1.48	2.0304	30.4563	0.0028	0.0418	46 41 33.62	13.6086	0.2116	76.55
4	8.4	10	51 5.279	312 46 19.19	2.0196	30.2934	0.0027	0.0408	47 0 25.47	13.6185	0.2103	76.52
5	8.4	9	51 9.711	312 47 25.66	2.0127	30.1898	0.0027	0.0401	47 12 7.86	13.6232	0.2095	76.50
6	8.4	10	51 18.735	312 49 41.03	+2.0206	+30.3089	+0.0027	+0.0411	47 0 17.11	+13.6329	+0.2102	76.52
7	7.3	12	51 36.635	312 54 9.53	2.0243	30.3641	0.0028	0.0418	46 56 20.98	13.6521	0.2104	76.54
8	8.5	7	51 36.763	312 54 11.44	2.0145	30.2179	0.0027	0.0407	47 12 13.63	13.6521	0.2093	76.58
9	8.2	10	51 39.421	312 54 51.32	2.0361	30.5412	0.0029	0.0430	46 37 14.23	13.6549	0.2116	76.71
10	8.6	12	52 22.211	313 5 33.16	2.0356	30.5346	0.0029	0.0436	46 42 55.87	13.7006	0.2109	76.54
11	8.4	7	52 25.144	313 6 17.16	+2.0130	+30.1945	+0.0027	+0.0412	47 20 23.03	+13.7037	+0.2084	76.73
12	8.6	9	52 28.382	313 7 5.73	2.0101	30.1512	0.0027	0.0409	47 25 25.04	13.7072	0.2081	76.50
13	8.1	11	52 43.745	313 10 56.17	2.0232	30.3485	0.0028	0.0426	47 5 51.98	13.7235	0.2092	76.53
14	7.8	9	53 6.586	313 16 38.79	1.9316	29.9739	0.0027	0.0401	47 48 50.44	13.7478	0.2062	76.82
15	8.4	11	53 14.095	313 18 31.42	2.0398	30.5974	0.0030	0.0448	46 42 3.79	13.7557	0.2106	76.53
16	9.0	10	53 52.925	313 28 13.87	+2.0404	+30.6062	+0.0030	+0.0454	46 45 41.44	+13.7969	+0.2100	76.52
17	8.1	12	54 1.661	313 30 24.92	2.0274	30.4127	0.0029	0.0442	47 8 1.25	13.8062	0.2085	76.54
18	8.2	5	54 6.296	313 31 34.44	2.0643	30.9642	0.0032	0.0480	46 7 5.33	13.8111	0.2123	76.07
19	8.4	12	54 15.734	313 33 56.01	2.0571	30.8560	0.0032	0.0474	46 20 26.60	13.8211	0.2114	76.54
20	8.9	10	54 15.984	313 33 59.76	2.0450	30.6752	0.0031	0.0462	46 40 45.28	13.8213	0.2102	76.51
21	9.1	9	54 26.301	313 36 34.51	+2.0312	+30.4674	+0.0030	+0.0450	47 4 57.09	+13.8323	+0.2085	76.61
22	9.0	4	54 44.696	313 41 10.44	2.0295	30.4423	0.0030	0.0450	47 9 53.18	13.8516	0.2081	76.57
23	9.0	12	55 4.060	313 46 0.90	2.0421	30.6318	0.0031	0.0467	46 51 17.68	13.8720	0.2091	76.54
24	8.0	12	55 6.921	313 46 43.82	2.0068	30.1020	0.0029	0.0428	47 49 23.25	13.8751	0.2053	76.54
25	8.8	12	55 20.511	313 50 7.67	2.0368	30.5518	0.0031	0.0464	47 2 7.34	13.8894	0.2083	76.54

Nos. 11, 16, 29, 31, 32, 45 are not found in A. G. C.

TABLE X.—FINAL CATALOG.—*Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″		″	° ′ ″	″	″	
26	8.3	12	20 55 26.816	313 51 42.24	+2.0624	+30.9355	+0.0033	+0.0490	46 19 56.52	+13.8959	+0.2109	1876.54
27	9.1	11	55 34.332	313 53 34.98	2.0376	30.5647	0.0031	0.0467	47 2 21.47	13.9039	0.2082	76.52
28	6.6	12	55 34.600	313 53 39.00	2.0379	30.5680	0.0031	0.0467	47 2 1.32	13.9042	0.2082	76.54
29	8.8	4	56 25.653	314 6 24.80	2.0320	30.4804	0.0031	0.0468	47 17 48.95	13.9577	0.2068	76.88
30	9.0	12	56 30.075	314 7 31.13	2.0573	30.8597	0.0033	0.0495	46 36 9.45	13.9623	0.2094	76.54
31	9.0	3	56 37.645	314 9 24.68	+2.0390	+30.5843	+0.0032	+0.0478	47 7 48.65	+13.9703	+0.2073	76.96
32	9.0	4	56 40.331	314 10 4.96	2.0437	30.6556	0.0032	0.0483	47 0 13.53	13.9731	0.2078	76.89
33	9.1	11	56 41.679	314 10 25.19	2.0252	30.3773	0.0031	0.0463	47 31 1.60	13.9745	0.2058	76.50
34	8.5	12	57 10.830	314 17 42.45	2.0562	30.8436	0.0033	0.0501	46 42 54.30	14.0049	0.2086	76.54
35	8.6	12	57 21.512	314 20 22.68	2.0465	30.6977	0.0033	0.0493	47 0 33.30	14.0161	0.2074	76.54
36	8.8	11	57 24.126	314 21 1.89	+2.0318	+30.4765	+0.0032	+0.0477	47 25 19.51	+14.0188	+0.2058	76.50
37	9.2	11	57 32.216	314 23 3.24	2.0358	30.5367	0.0032	0.0483	47 19 42.37	14.0273	0.2061	76.62
38	7.9	12	57 38.790	314 24 41.85	2.0649	30.9732	0.0034	0.0514	46 31 39.50	14.0341	0.2091	76.54
39	9.1	11	57 49.698	314 27 25.47	2.0445	30.6674	0.0033	0.0495	47 7 22.23	14.0455	0.2068	76.53
40	8.7	11	58 20.835	314 35 12.52	2.0318	30.4768	0.0032	0.0486	47 32 14.44	14.0779	0.2050	76.53
41	8.5	11	58 46.493	314 41 37.39	+2.0644	+30.9664	+0.0035	+0·0524	46 40 45.34	+14.1045	+0.2080	76.53
42	8.0	10	59 13.250	314 48 18.75	2.0732	31.0978	0.0036	0.0537	46 29 5.42	14.1322	0.2084	76.58
43	7.0	12	59 24.025	314 51 0.38	2.0780	31.1695	0.0036	0.0544	46 22 10.63	14.1433	0.2088	76.54
44	8.3	11	59 32.091	314 53 1.36	2.0702	31.0523	0.0036	0.0538	46 36 37.35	14.1516	0.2078	76.53
45	8.3	4	21 0 38.119	315 9 31.78	2.0613	30.9194	0.0036	0.0540	46 59 57.95	14.2197	0.2059	76.80
46	8.2	12	0 40.309	315 10 4.64	2.0482	30.7230	0.0035	0.0527	47 22 18.12	14.2220	0.2045	76.54

No. 12. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF SIXTY-FIVE
NEAR 61 CYGNI, BY HERMAN S. DAVIS. Annals of the Nev
Academy of Sciences. Vol. X., pp. 58–121. August, 1897. C

No. 13. THE PARALLAXES OF 61¹ AND 61² CYGNI DEDUCED FROM THE
FURD PHOTOGRAPHIC MEASURES, BY HERMAN S. DAVIS. An
the New York Academy of Sciences, Vol. X., pp. 123–160. A
1897. Octavo.

No. 14. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THIRTY-FOUR
NEAR "BRADLEY 3077," BY HERMAN S. DAVIS. Annals of th
York Academy of Sciences, Vol. X., pp. 161–187. August, 1897. C

No. 15. THE PRÆSEPE GROUP; MEASUREMENT AND REDUCTION OF THE
ERFURD PHOTOGRAPHS, BY FRANK SCHLESINGER. Annals of th
York Academy of Sciences, Vol. X., pp. 188–286. May, 1898. C

No. 16. THE POSITIONS AND PROPER MOTIONS OF THE PRINCIPAL ST
THE CLUSTER OF COMA BERENICES AS DEDUCED FROM ME
MENTS OF THE RUTHERFURD PHOTOGRAPHS, BY WALTER C. K
Annals of the New York Academy of Sciences, Vol. XII., pp. 34
February, 1900. *Octavo.*

No. 17. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THE GROUP O
PLEIADES (Second Paper), BY HAROLD JACOBY. Pp. 24, Ja
1901. *Octavo.*

No. 18. THE PARALLAX OF μ CASSIOPEIÆ AND THE POSITIONS OF 56 N
BORING STARS AS DEDUCED FROM THE RUTHERFURD PHOTOGR
MEASURES, BY GEORGE N. BAUER. Pp. 102. April, 1901. O

No. 19. CATALOGUE OF 287 STARS NEAR THE SOUTH POLE, AND OPTICA
TORTION OF THE CAPE OF GOOD HOPE ASTRO-PHOTOGRAPHIC
SCOPE, BY HAROLD JACOBY. Pp. 70. April, 1902. *Octavo.*

No. 20. The SUMATRA ECLIPSE, 1901. SPECTROGRAPHIC STUDY OF THE
SPECTRUM: NEW GASES IN THE SUN, BY S. A. MITCHELL. P
November, 1903. *Octavo.*

No. 21. PHOTOGRAPHIC CATALOGUE OF 829 STARS NEAR THE SOUTH PO
THE HEAVENS; AN EXAMPLE OF INTER-ADJUSTING OVERLA
PLATES, BY HAROLD JACOBY. Pp. 153. January, 1904. *Octav*

No. 22. RESEARCHES AS TO THE IDENTITY OF THE PERIODIC COMET OF
1896–1903 (BROOKS) WITH THE PERIODIC COMET OF 1770 (LEXEL
CHARLES LANE POOR. Pp. 82. December, 1904. *Octavo.*

No. 23. TABLES FOR THE REDUCTION OF ASTRONOMICAL PHOTOGRAPH
HAROLD JACOBY. Pp. 24. February, 1905. *Octavo.*

No. 24. RUTHERFURD PHOTOGRAPHS OF THE STELLAR CLUSTERS h AND χ P
BY ANNE SEWELL YOUNG. Pp. 76. September, 1906. *Octavo.*

No. 25. RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING 59 CYGN
HAROLD JACOBY. Pp. 23. April, 1908. *Octavo.*

* Contributions numbered 1 to 7 and 10 to 15 (inclusive) have been gathered togeth
volume of 614 pages entitled RUTHERFURD: STELLAR PHOTOGRAPHS: VOL. I.; PLE
CYGNUS: CASSIOPEIÆ: PRÆSEPE, by REES, JACOBY, DAVIS AND SCHLESINGER, 1898.

The volume is supplied with a consecutive pagination, table of contents and a prefac
Only a few volumes have been distributed because of the scarcity of several of the p

Beginning with No. 16 all contributions relating to the Rutherfurd Photographs w
paged consecutively at the bottom of the pages, and in due time will be assembled in a
Rutherfurd volume.

LIST OF
CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY, NEW YORK.

LISTS OF ERRATA IN CONTRIBUTIONS FROM THE OBSERVATORY OF COLUMBIA UNIVERSITY WILL BE FOUND IN CONTRIBUTIONS 19, p. 68, and 24, p. 74.

No. 1. LEWIS MORRIS RUTHERFURD, BY JOHN K. REES. Pp. 15. July, 1906. *Octavo.*

No. 2. A CATALOGUE OF RUTHERFURD'S PHOTOGRAPHIC PLATES OF THE SUN, THE MOON AND THE STARS, BY JOHN K. REES. Pp. 7. July, 1906. *Octavo.*

No. 3. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THE GROUP OF THE PLEIADES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. VI., pp. 239–330. February, 1892. *Octavo.*

No. 4. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THE STARS ABOUT β CYGNI, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol, VI., pp. 331–348. May, 1892. *Octavo.*

No. 5. THE PARALLAXES OF μ AND θ CASSIOPEIÆ DEDUCED FROM RUTHERFURD PHOTOGRAPHIC MEASURES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. VIII., pp. 1–23. March, 1893. *Octavo.*

No. 6. THE PARALLAX OF η CASSIOPEIÆ DEDUCED FROM THE RUTHERFURD PHOTOGRAPHIC MEASURES, BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences, Vol. VIII., pp. 301–321. April, 1895. *Octavo.*

No. 7. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF SIXTY-TWO STARS ABOUT η CASSIOPEIÆ, BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences, Vol. VIII., pp. 381–416. June, 1895. *Octavo.*

No. 8. DECLINATIONS AND PROPER MOTIONS OF FIFTY-SIX STARS, BY HERMAN S. DAVIS, PH.D. Memoir I., Part 1, New York Academy of Sciences, pp. 105. June, 1895. *Quarto.*

No. 9. THE VARIATION OF LATITUDE AT NEW YORK CITY FROM OBSERVATIONS BY JOHN K. REES, HAROLD JACOBY AND HERMAN S. DAVIS. MEMOIR I., Part 2, New York Academy of Sciences, pp. 236. July, 1906. *Quarto.*

No. 10. ON THE REDUCTION OF STELLAR PHOTOGRAPHS, WITH SPECIAL REFERENCE TO THE ASTRO-PHOTOGRAPHIC CATALOGUE PLATES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. IX., pp. 101–123. April, 1896. *Octavo.*

No. 11. ON THE PERMANENCE OF THE RUTHERFURD PHOTOGRAPHIC PLATES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. IX., pp. 195–284. October, 1896. *Octavo.*

[illegible]
[illegible]

Contributions from the Observatory of Columbia University, New York.—
No. 26.

An Investigation of the Figure of the Sun and of Possible Variations in its Size and Shape

By

Charles Lane Poor

[Reprinted from the Annals of the New York Academy of Sciences, Vol. XVIII, No. 9, Part III,
pp. 385–424. Published 29 August, 1908.]

Contributions from the Observatory of Columbia University, New York.—
No. 26.

An Investigation of the Figure of the Sun and of Possible Variations in its Size and Shape

By

Charles Lane Poor

[Reprinted from the Annals of the New York Academy of Sciences, Vol. XVIII, No. 9, Part III,
pp. 385–424. Published 29 August, 1908.]

Attention is called to the Lists of Errata in former Contributions from the Observatory to be found in Publication 19, p. 68 and Publication 24, p.74.

[ANNALS N.Y. ACAD. SCI., Vol. XVIII, No. 9, Part III, pp. 385–424. 29 August, 1908.]

AN INVESTIGATION OF THE FIGURE OF THE SUN AND OF POSSIBLE VARIATIONS IN ITS SIZE AND SHAPE.

BY CHARLES LANE POOR.

CONTENTS.

PART I. HISTORICAL.

Introductory Note 386
Meridian Observations 386
  Von Lindenau 386
  Bianchi 387
  Secchi 387
  Hilfiker 387
Discussion of Meridian Observations 388
  Auwers 388
  Newcomb and Holden 389
  Auwers 390
Heliometer Measures 394
  Measures made in Connection with Transit of Venus 395
  Observations of Schur and Ambronn 396

PART II. PHOTOGRAPHIC MEASURES.

  Rutherfurd Plates 403
  Northfield Plates 406
  Yerkes Plates, The Photo-heliometer 407

PART III. DISCUSSION OF OBSERVATIONS AND RESULTS.

The Figure of the Sun 409
  A New Tabulation of the German Heliometer Measures 409
  Tabulation of Results 413
  Conclusions 414
Variability of the Sun's Diameter 415
  Fluctuations having the Same Period as the Sun-spots 416
  Search for Short Term Periodic Variations 418

PART IV. CONCLUSIONS.

PART I. HISTORICAL.

INTRODUCTORY NOTE.

Questions as to the exact size and shape of the sun are of great astronomical interest and have been made the subjects of many researches during the last hundred years. Many of these investigations, involving long series of observations, show a distinct ellipticity of the sun and indicate a possible variation of its diameter, yet, after a thorough re-discussion of these observations, Auwers concludes that all such indications are illusory and that the sun is sensibly a sphere of constant diameter. As a result of an independent discussion, Newcomb confirms this conclusion of Auwers, and traces the supposed observed variations to changes in terrestrial temperature and to fluctuations in the haziness and cloudiness of the earth's atmosphere. As these investigations and discussions appeared in various journals and publications of scientific societies, it may not be without value to preface the present investigation with a *résumé* of the more important papers, and to show exactly upon what grounds Auwers and Newcomb base their conclusions.

Measures of the sun's diameter which have heretofore been used are of two classes; 1st, Those made with a meridian circle or transit instrument, and, 2d, Those made with a heliometer. The papers and discussions relating to these two classes will be taken up separately, although this will interfere with the chronological order in which the papers actually appeared.

MERIDIAN OBSERVATIONS.

VON LINDENAU. — The first important investigation was that of Von Lindenau, which appeared in Zach's "Monatliche Correspondenz" for June, 1809. From observations made at Seeberg, in 1808–09, with a transit instrument, he found a periodic variation in the sun's diameter. In order to test this suspected variation, he discussed the Greenwich meridian observations made in the years 1750–55 and 1765–86. These observations apparently confirmed the results obtained from those made at Seeberg, and Lindenau concluded that the sun is an ellipsoid, rotating about its longer axis. His calculations made the polar radius exceed the equatorial by from 4″ to 6″, or, what is the same thing, he found an equatorial compression of $\frac{1}{280}$ to $\frac{1}{140}$. These results, however, were criticised the following month by Bessel,[1] who showed that the observations could be represented equally well by periodic changes in the transit instrument itself.

BIANCHI. — Piazzi[2] and afterwards Bianchi[3] investigated the subject, and reached conclusions diametrically opposed to those of Lindenau. While they found the sun to be an ellipsoid, they made the equatorial radius the greater. Bianchi based his work on some 440 measures of the vertical and 439 of the horizontal diameter made during the years 1827, 1828 and 1829. From the measures of the vertical diameter alone, he deduced a polar compression of $\frac{1}{1925}$; from the horizontal measures, a compression of $\frac{1}{110}$; while from a combination of all the observations, he found the value $\frac{1}{249}$. This latter value would make the equatorial exceed the polar radius by some 3″.87.

SECCHI. — In spite of these papers, the generally accepted conclusion was that the solar disk was circular and its diameter constant. Not until after a lapse of forty years was the subject reopened. In 1871 Secchi became interested in the question of the sun's shape, and, with his assistant Rosa, undertook a systematic series of observations with the meridian circle of the Collegio Romano. As these observations apparently showed great variations in the sun's diameter, Secchi induced the Palermo Observatory to make an independent series of measures. These confirmed the results obtained at Rome. According to these investigations,[4] the diameter of the sun varied with the number of sun-spots, being greatest when the number of spots was least, and least when the number of spots was greatest. In conformity with this, he also found that those diameters which pass through regions of intense spot-activity are less than those passing through other regions. He found the diameter which passes through latitude 21° to 23° to be some 1″.56 smaller than the diameter which passes through latitude 6°.

HILFIKER. — Hilfiker, assistant at the Observatory of Neuchâtel, published the results of twenty-two years' observations. In all he made use of 3468 homogeneous transits of the sun, all observed with the same instrument and in precisely the same manner. This instrument had an objective of 115 mm. aperture and 2 m. focal length. In making the observations, a uniform magnification of 200 was used, and each limb of the sun was observed on thirteen threads of the reticle. From this great mass of observations, Hilfiker drew the definite conclusion that the sun's diameter is variable and that it varies with the number of visible sun-spots. He found the diameter of the sun to be greater when the number of spots is a minimum, to be smaller when the number is a maximum. In this conclusion he agreed with Secchi, with the observations made at Rome and Palermo.

---

[1] Zach, Monatliche Correspondenz, July, 1809.

[2] Specola Astronomica di Palermo, Liv. VI.

[3] Astronomische Nachrichten, Vol. IX, No. 213, August, 1831.

Atti dell'Accademia dei Lincei, January, 1872.

DISCUSSION OF MERIDIAN OBSERVATIONS.

Auwers. — The results derived by Secchi depended upon a very small number of observations (187), and they covered a period of only one year; yet they attracted considerable attention, and caused Auwers to undertake a complete discussion of the entire matter of the sun's shape and its possible variability. This resulted in a series of papers, published by the Berlin Academy, which are distinguished by their thoroughness and by the great skill of the author. In these papers Auwers clearly shows the utter unreliability of the observations upon which Secchi depended, and concludes that "the assertions concerning variations in the sun's diameter are totally and entirely unfounded."

In the first paper of this series,[1] Auwers examined a mass of observations made in the years 1871–72, at Greenwich, Neuchâtel, Oxford, Washington, Paris, Königsberg and Brussels, and showed that the different series of observations furnished conflicting results. These series covered the period of time during which were made the observations upon which Secchi relied; and the entire disagreement between the various sets of observations led Auwers to the conclusion that the changes noticed by Secchi were due to "casual errors of observations." The Oxford series showed a distinct relation between the diameter and the sharpness of the image. When the sky was more or less overcast and the image indistinct, the measured diameter was greater. Dividing the observations into five classes, according to the state of the weather, he found the following mean residuals for each class:

Class.	Residuals.	No. of Observations.	
Best image	$-0^{s}.020$	1	
Very sharp	$+0^{s}.147$	4	$0^{s}.129$ (7.)
Sharp; thin clouds	$+0^{s}.103$	3	
Many clouds	$+0^{s}.237$	8	$0^{s}.264$ (24)
Clouds	$+0^{s}.277$	16	

This dependence of the measured diameter upon the state of the atmosphere, or the astronomical "seeing," was also found by Wagner,[1] and was corroborated by Gyldèn at Pulkowa, by Becker at Neuchâtel and by Newcomb and Holden[2] at Washington. The Washington observations show clearly that both the vertical and horizontal diameters vary with the amount of cloudiness in the sky. In bright weather, when the image was clear and sharp, the diameters as measured were smaller than when the sky was overcast, or was more or less covered by clouds.

---

[1] Ueber eine angebliche Veränderlichkeit des Sonnendurchmessers, Monatsberichte of the Royal Academy of Sciences at Berlin, May, 1873.

In the paper above referred to, Auwers also investigated two long series of Greenwich observations; one made by Bradley and Maskelyne between the years 1750 and 1786, and the other made during the years 1851–70. The intervening years were partly covered by two shorter series; one made by Bessel at Königsberg in the years 1820–28, and the second by W. Struve at Dorpat in 1823–38. These series all showed small variations in the measured diameter; but when these variations were compared with the fluctuations in the number of sun-spots, no dependence of the one phenomenon upon the other could be traced. As to the minute variations shown by the observations, Auwers concluded that there was "no indication whatever of the reality of these fluctuations."

NEWCOMB AND HOLDEN. — Newcomb and Holden[3] investigated the subject of possible variations in the diameter in an entirely different manner. If there be two independent series of simultaneous observations, and the difference between each measure and the mean of the whole series to which it belongs be taken, then, if the differences are due entirely to accidental errors, there will be no relation between the differences of the two series. If, on the other hand, a portion of the difference is due to actual change in the sun, then, as a general rule, positive differences in one series will correspond to positive differences in the other, and negative differences to negative differences. When the corresponding differences of one series are multiplied by those of the other, and the sum of all the products taken, then, if there be a real change in the sun, this sum should be a large positive quantity.

Unfortunately no such simultaneous series were available. The two series which most nearly satisfied the conditions were those made at Greenwich and Washington during the years 1862–70. Instead of being simultaneous, the observations were thus separated by an interval of about five hours. These series contained a total of 3639 observations, of which number 1813 were of the horizontal and 1826 of the vertical diameter. Of this large number, however, only 584 were made on corresponding days and were available for the test. These observations were freed from personal equation, and the resulting series of residuals found. Each Washington residual was multiplied by the corresponding Greenwich residual, and the sum of the products taken with the following results:

---

[1] Vierteljahrschrift, January, 1873.

[2] On the Possible Periodic Changes in the Sun's Apparent Diameter (American Journal of Sciences and Arts, October, 1874).

[3] On the Possible Periodic Changes in the Sun's Apparent Diameter (American Journal of Sciences and Arts, October, 1874).

	HOR. DIAM.	VERT. DIAM.
Sum of products	—$0^s.1077$	—$23''.14$
Number of observations	313	271

This preponderance of negative products would show that positive residuals at Greenwich are followed five hours later by negative residuals at Washington and *vice versâ*. This would apparently indicate vibrations in the sun of short period, somewheres around ten hours' duration. Again, the result seems, according to Newcomb, to be conclusive against any variability whose period is a multiple of a day.

The apparent short-period vibration is, however, attributed by the authors to chance.

AUWERS. — Auwers[1] enlarged the scope of his investigation, and discussed all available transit material. This included the following long series:

Greenwich Observations . . .	1851–83	Radcliffe Observations .	1862–83
Washington Observations . .	1866–82	Neuchâtel Observations .	1862–83

and a number of shorter series.

Practically every series showed fluctuations, more or less periodic, in the observed diameters; and an investigation as to the reality or non-reality of these apparent fluctuations formed the main part of Auwers' papers. These apparent variations fell into two classes; 1st, Irregular or long period variations, and, 2d Annual variations.

In discussing the variations of the first class, Auwers carefully investigated the personal equations of the ninety-two observers who took part in the four main series of observations. These personal errors were determined in the usual manner. In each series the observations (mean of each year) of each observer were compared with the corresponding mean of all the observers, or with that of a standard observer or observers. In the case of the Greenwich series, the mean of four observers, — Dunkin, Ellis, Criswick and J. Carpenter [the observers who had the largest consecutive series of observations], — was taken as standard. With the personal equations so determined, the observations were reduced, and the results showed periodic variations, which at first sight bore some resemblance to the variations in the sun-spot frequency.

---

[1] Neue Untersuchungen über den Durchmesser der Sonne, I, II (Sitzungsberichte of the Berlin Academy, December, 1886 and June 9, 1887).

During the period 1862–72 this resemblance was more striking than in periods before and after those dates. In investigating the probability of a connection between the diameters as observed in each series, and the number of sun-spots, Auwers assumed that, if present, such connection could be expressed by the equation

$$V = x + A.y$$

where V is the residual obtained by subtracting the mean of all the horizontal diameters from the mean of each year, and A is a number arbitrarily obtained for each year by Auwers, from Wolf's "relative number" for that year and from the observed magnetic variations during that year. From such equations for each year, as given by the Greenwich and Washington observations for the central period, Auwers found by least squares the values

$$x = +0.030$$
$$y = -0.500$$

with a weight of 2.73 and a mean error of 0.198 for y. Thus y was over twice its mean error, a result which seemed to confirm a connection between the observed diameter and the sun-spot period.

Auwers also plotted the yearly residuals of the Greenwich and Washington observations in connection with the sun-spot curve, and the relation between the two was again clearly indicated. Thus the observations, when interpreted graphically or mathematically, point toward a close connection between the variations in the diameter and those in the number of visible sun-spots.

Not content with this conclusion, Auwers proceeded further and investigated the various series of observations made by the individual observers. In these individual series of residuals he found variations, some abrupt, some periodic. These changes in an observer's residuals he now assumes as due to changes in the personal equations rather than to changes in the measured quantity. When abrupt changes in the residuals are found, corresponding abrupt changes in the observers' personal equations are assumed; when gradual periodic changes in the residuals are seen, corresponding periodic changes in the personal equation are taken. Thus, in his second or definitive reduction of the Greenwich and Washington observations, Auwers assumes arbitrary and variable personal equations for the different observers. Some of the more important of the fifty-seven personal equations of the Greenwich observers as used by Auwers are given in the following table. Under the head "First System" will be found the values of personal equations as determined by Auwers in his first reduction; under the head "Second System" will be found the variable equations used in the second reduction:

Table I.

	FIRST SYSTEM.		SECOND SYSTEM.	
Dunkin	$+0^s.084$ $+0^s.025$	1861	$+0^s.058—0s.006(t—1860.5)$	
Downing	$—0^s.023$		$—0^s.010+0s.010(t—1878.5)$	
Thackeray	$+0^s.038$		$—0^s.014$ $+0^s.063$	1876
Stone	$—0^s.057$		$—0^s.135$ $+0^s.041$	1863
Pead	$—0^s.034$		$—0^s.035$ $+0^s.013$	1880
H. Breen	$+0^s.221$ $—0^s.021$	1855	$+0^s.230$ $—0^s.028$	1855
Criswick	$+0^s.062$		$+0^s.061$	
J. Carpenter	$—0^s.095$		$—0^s.099$	

The dates following a bracket indicate the year in which an abrupt change in personal equations was adopted. The system of equations adopted for the vertical diameters was still more complicated; those of Dunkin, Ellis, Criswick, J. Carpenter and H. Carpenter varying with the time. The personal equation of Criswick contained a term involving the square of the time, and that of Ellis showed an abrupt change in 1871. Besides these, the equations of Lynn, Downing and Thackeray, show abrupt changes.

By using this new set of personal equations, Auwers was enabled to reduce the apparent variations in the observations, so that all semblance of periodicity disappeared; and, because the outstanding residuals are so reduced, he concludes that this system best represents the observations, and that the diameter of the sun is constant while the personal equations of the different observers are variable. This may be the true explanation of the observed discordances; but it is evident that, with a different system of variable personal equations, an entirely different result could be obtained.

By similar discussions of all the various series of observations made between 1851 and 1883, Auwers reached the conclusion that the meridian observations showed no long-period variation, nor any long existing change in the sun's diameter, of a greater amplitude than ± 0″.2.

As to the second class, or annual variations, Auwers investigated nineteen independent series of observations, made at seven different observatories and with twelve different instruments. In all, these series contained more than 21,000 observations of the horizontal diameter and about half as many more of the vertical diameter. From sixteen of these series, containing more than 26,000 observations, Auwers found, after eliminating the effects of personal errors, that the diameter was either constant for the entire year, or showed variations of such form and size as to be clearly the result of temperature upon the instruments. In these series he found the measured diameter to be the smallest when the image was sharpest, and at those temperatures when the threads of the reticle were exactly in the focal plane of the objective.

The three remaining series showed annual variations which could not be accounted for by the effects of temperature. In the Madras series, Auwers traced the apparent variation to personal errors of the various observers. The other two series which showed variations were those very early observations of Maskelyne and Lindenau. To these series Auwers devoted a separate paper,[1] and in it he showed Lindenau's deductions to be entirely unfounded. In the early Greenwich observations many cases occurred in which the second limb of the sun was observed on different threads from those used for the first. Such observations can only be utilized when the thread-intervals are known. Now Lindenau confined his discussion to observations made on the same threads, while Auwers took into account all the observations. To do this Auwers had first to find, from other observations, the thread-intervals; but, while this work was extremely laborious, it enabled Auwers ultimately to utilize three times as many observations as did Lindenau. Still further, Auwers found the Greenwich observations to be a heterogeneous mass made by different observers, by Maskelyne and his assistants. He discussed the personal equations of these various observers, eliminated their effects and finally obtained results radically different from those of Lindenau, — results which showed no trace of variability in the sun's diameter.

The possible departure of the sun from a spherical shape was also discussed by Auwers in these three papers. At Greenwich, Washington and Radcliffe, the vertical as well as the horizontal diameter was measured. Auwers discussed these observations separately, and found the results as given below:

---

[1] Neue Untersuchungen über den Durchmesser der Sonne, III (Sitzungsberichte of the Berlin Academy, October 31, 1889).

Table II.

	DIAMETER.		NO. OF OBSERVATIONS.		NO. OF OBSERVERS.
	Horizontal.	*Vertical.*	*Hor.*	*Vert.*	
Greenwich	32′ 2″.01	32′ 2″.73	3114	3289	62
Washington	32′ 2″.41	32′ 2″.57	1321	1297	15
Radcliffe	32′ 2″.87	32′ 3″.51	—	—	7
Neuchâtel	32′ 3″.27	—	—	—	8

In each of three series, therefore, the vertical diameter appears as larger than the horizontal.

The inclination of the sun's equator to the horizontal line changes with the season of the year. If, therefore, the sun had a marked ellipticity, the measured horizontal and vertical diameters would each show periodic variations, the length of the cycle being six months. If the equatorial diameter exceeded the polar by 1″, then Auwers showed that, at the date of the observations, the measured mean for any month should exceed the yearly mean by the value

$$\pm (0''.01 \sin 2t + 0''.09 \cos 2t)$$

where t is the fractional part of the year; and the upper sign applies to horizontal measures, while the lower one applies to vertical diameters. Giving the Greenwich and Neuchâtel observations weights of 3, the Washington observations 2, and those of Radcliffe 1, Auwers, from the mean of all the observations, found the expressions

Horizontal diameter . . . . . $-0''.01 \sin 2t + 0''.06 \cos 2t$
Vertical diameter . . . . . $-0''.01 \sin 2t - 0''.04 \cos 2t$

And these expressions show absolutely no relation with the real form of the expression as above given.

Auwers concluded, however, that a polar compression of $\frac{1}{4000}$, or an excess of 0″.5 of the equatorial over the polar diameter, would best represent all the observations.

HELIOMETER MEASURES.

In the first of the before-mentioned series of papers,[1] Auwers examined two short series of heliometer measures made by Schlüter and Wichmann in 1842–43 and 1846–51. The observations were too few in number to allow any certain conclusion to be drawn, but they indicated a change in the diameter. Schlüter also measured on a few days both the polar and equatorial diameters, and, as a result of these measures, the polar diameter appeared to exceed the equatorial by a small fraction of a second.

---

[1] Monatsberichte of the Royal Academy of Sciences at Berlin, May, 1873.

MEASURES MADE IN CONNECTION WITH TRANSIT OF VENUS. — While adjusting and determining the constants of the heliometers which were used in observing the transits of Venus in 1874 and 1882, the German observers made a great number of determinations of the sun's diameter. In all, some 2692 separate measures of the diameter were made by twenty-three observers. Five heliometers were used, measures with the same instrument being made in various stations by the same observer and in the same station by various observers. Thus heliometer A was used by Adolph, Wittstein, Valentiner, Ambronn, Peters, Kobold, Deichmuller, Hartwig, Kustner and Weinek in Strassburg; by Adolph and Valentiner in Tschifu; and by Franz and Kobold in Aiken.

This immense mass of data was most thoroughly discussed by Auwers in "Die Venus-Durchgänge, 1874 und 1882"; the conclusions being published in the "Astronomische Nachrichten." [1] These measures were all reduced to distance unity and arranged in groups, the observations made with each instrument being subdivided for each observer and also for each place of observation. From the observations made with the different heliometers, Auwers reached the conclusion that D and E gave smaller images than A, B and C, and he deduced corrections for the five instruments, so as to reduce the measures made with each to the mean of A + B + C + D + ½ E. These corrections are given by the table,

For A	—0″.01	For D	+0″.18
For B	—0″.20	For E	+0″.16
For C	—0″.06		

With these corrections the observations were reduced and the results for the various observers tabulated. The observations of Hartwig made the diameter the greatest, 1920″.29, while those of Clauss made it the least, 1918″.38: the difference between these two observers thus amounted to 1″.91. To these various means Auwers assigned weights, and finally deduced the value for the diameter of the sun at distance unity as

$$1919''.26 \pm 0''.10.$$

---

[1] Astronomische Nachrichten, Vol CXXVIII, No. 3068, December, 1891.

These observations were made along different diameters of the sun; some were made on the equatorial diameter; some, at right angles to the equator; and others, at various position angles. In all, nineteen sets of observations were made which directly gave the difference between the equatorial and polar diameters, and twenty-seven sets in which inclined pairs of diameters were measured. From these, Auwers found that the polar diameter exceeds the equatorial by

	P.-E.
In the 19 sets	+0″.026
In the 27 sets	+0″.053

And from the weighted mean of the whole series, he found that

P.-E.= +0″.038 ± 0″.023.

This apparent anomaly in the shape of the sun was explained by Auwers as being due to the tendency on the part of an observer to measure vertical diameters greater than horizontal diameters, and he concluded therefore that the sun is sensibly a sphere.

The mean diameter of the sun as determined from these observations does not show any variation with the time. The observations were made practically around the whole circumference of the solar disk, and mostly fall into two great groups, the first containing those made in 1873–75, and the second those made in 1880–85. There were two short series of observations made in 1876–77, not included in either group. The weighted means of the two great groups are practically identical, the mean of the second group exceeding that of the first by only

+0″.04,

a quantity less than half the probable error of the mean of the entire series as given by Auwers

± 0″.10.

OBSERVATIONS OF SCHUR AND AMBRONN. — In 1905 Ambronn published, under the title "Die Messungen des Sonnen-durchmessers,"[1] a most exhaustive and valuable research upon the shape and size of the sun. This paper embodies the results of the solar investigations of Schur and Ambronn, made with the six-inch Repsold heliometer of the Göttingen

---

[1] Astronomische Mittheilungen der k. Sternwarte zu Göttingen, Theil 7, 1905.

Observatory during a period of nearly thirteen years, from 1890 to 1902, and it furnishes the best and most precise series of measures of the sun's diameter which have yet been made.

When the Repsold heliometer was mounted in Göttingen, Schur determined to investigate this subject thoroughly, and to make with that instrument a complete and uniform series of measures which should extend over the whole of a sun-spot period. In carrying out this programme, every conceivable precaution was taken to exclude systematic errors: in fact, two complete, parallel and independent series of observations were made, one by Schur and one by Ambronn. Whenever possible, each observer obtained a series of four measures each week, two of the polar and two of the equatorial diameter. All the necessary instrumental constants for the reduction of these observations were obtained by each observer independently of the other. But the same methods and the same formulas of reduction were used in the two series; so that these series are directly comparable. The series of Schur extends from 1890 to the beginning of 1901; that of Ambronn, from 1890 to the end of 1902; both series thus covering an entire sun-spot period.

In reducing and discussing this great number of observations, Ambronn investigates the questions of the figure and of the variability of the sun separately. A brief *résumé* of his methods of investigating each of these points is given below, together with the conclusions he reaches in regard to these important questions.

1. *The Figure of the Sun.* — On each day of observation the polar and equatorial diameters were both measured twice, so that the research furnishes a great mass of data regarding the shape of the sun. The values of the differences between the diameters, in the sense polar minus equatorial, are tabulated and given by Ambronn. From these are formed the mean values of this difference for each year; and from these yearly means, the mean value for the entire series of observations.

The yearly means as given by Ambronn in Appendix IV, and also on page 44 of his memoir, contain typographical errors which were later corrected by the author.[1] The corrected table is as follows:

---

[1] Astronomische Nachrichten, Vol. CLXXI, No. 4086. May, 1906.

Table III.

MEAN OF YEARS (P.–E.).

YEAR.	SCHUR		AMBRONN.		MEAN.	WEIGHTED MEAN.	WT.
	P.–E.	No. of Obs.	P.–E.	No. of Obs.	P.–E.	P.–E.	
1890 . . .	+0.13	10	+0.12	14	+0.12	+0.13	6
1891 . . .	+0.02	17	+0.14	14	+0.08	+0.08	6
1892 . . .	—0.06	12	+0.07	16	0.00	+0.02	7
1893 . . .	—0.09	10	—0.01	14	—0.06	—0.07	6
1894 . . .	+0.10	11	—0.07	11	+0.02	—0.04	10
1895 . . .	+0.04	13	+0.03	15	+0.04	+0.03	9
1896 . . .	—0.05	19	—0.01	18	—0.03	—0.03	8
1897 . . .	+0.02	26	—0.04	21	—0.01	—0.01	13
1898 . . .	+0.11	21	+0.07	21	+0.09	+0.08	11
1899 . . .	+0.05	21	—0.03	24	+0.01	—0.01	12
1900 . . .	+0.04	24	+0.01	21	+0.02	+0.02	20
1901 . . .	+0.43	1	+0.06	27	—	+0.07	10
1902 . . .	—	—	—0.06	15	—	—0.06	5

The column "Mean" is from Ambronn; that headed "Weighted Mean" was formed by assigning weights to the observations of Schur and Ambronn in conformity with the values of the mean error for each year of a single observation as given by Ambronn. Upon the assumption that the shape and size of the sun are constant for each year, Ambronn found, from the separate observations made during that year, the value of the mean error of a single observation, and these mean errors are tabulated in Appendix IV. From these and the number of observations were found by the ordinary formulas the weights assigned to the yearly means.

The observations during the first two years, 1890–91, were made under instrumental conditions different from those during the rest of the interval. In order to find definitive results, therefore, Ambronn forms the means of all the observations, and also means excluding these two years. These means are given as follows:

	SCHUR.	AMBRONN.	MEAN.
Mean of all observations	+0″.028	+0″.022	+0″.025
Mean excepting the years 1890–91 . . .	+0″.018	+0″.002	+0″.010

The final mean as thus given by Ambronn shows that the polar diameter exceeds the equatorial by

+0″.025 ± 0″.018,

a quantity which agrees closely with that (0″.038) obtained by Auwers from the transit of Venus observations. The mean errors of the individual results are given by Ambronn as

From Schur	±0″.021
From Ambronn	±0″.013

And these are nearly, if not quite, as large as the quantity sought. Ambronn concludes, therefore, that the deviations are accidental and that the sun is sensibly a sphere.

In testing this result, Ambronn investigates the effect of the inclination of the measured diameter on the result to determine whether there was any tendency on the part of the observer to measure vertical diameters differently from horizontal.

He could find no such effect; but he calls special attention to the observations made during the two years 1890 and 1891, which show the polar diameter to be decidedly the greater, and points out the fact that these results may be due to physiological causes, for during this interval no precautions were taken to obviate this difficulty. A prism was attached to the heliometer in October, 1891, in such a manner that all the diameters of the sun were measured in the same relative positions as regards the vertical; and from that date on, the observations are perfectly homogeneous.

Ambronn also investigates the possibility of errors in the constants of refraction which were used in reducing the observations. In the winter months the sun was at an average lower altitude at the time of observation than in the summer months. Hence, if there were any systematic errors in computing the differential refraction, such errors would be apparent when the observations are grouped according to the months in which they were made. When the observations are so grouped, no periodic variation is shown; and Ambronn concludes, therefore, that the constants and the methods used in computing the differential refraction are sensibly correct.

2. *Variation of the Sun's Diameter.* — Each series of observations is treated separately. Ambronn first finds the mean value of the sun's diameter from all the observations of each series; then, subtracting this mean from the separate values, he finds the residual for each observation. From these residuals he finds the value of the mean residual for each year, and tabulates these "yearly residuals," which thus show the yearly variation in the diameter.

In the first of these steps, Ambronn was confronted with a difficulty: the series of observations were not strictly homogeneous. In October, 1891, a prism was introduced into the instrument in such a manner that the line joining the centers of the two images could always be brought into the same position relative to the eyes of the observer. This was to obviate any possible physiological influence which might cause the observer to measure the polar and equatorial diameters differently. An investigation, however, showed that the prism had a sensible effect upon the measures of all diameters, equatorial as well as polar. The diameters measured with the prism were all somewhat smaller than those measured without it. As the prism was used continuously after October, 1891, the series of observations are divided into two periods by this date. The mean results from the observations in each period are given below, where the various values are expressed in scale-divisions, one division of the scale being approximately equal to 40″.

Table IV.

	WITHOUT PRISM.	NUMBER.	WITH PRISM.	NUMBER.
Schur	47.9919	25	47.9823	159
Ambronn	47.9819	27	47.9745	200

As a result of special measures made by Schur and Ambronn, both with and without the prism, Ambronn concludes that all observations made without the prism must be diminished by 0″.4 or 0.01 scale-division, in order to make them comparable with those made with the prism.

Correcting all the observations made without the prism by this amount, taking the general means, and reducing scale to arc, Ambronn finally obtains for the definitive values of the sun's diameter at distance unity.

Schur	1920″.14	±0″.040
Ambronn	1919″.80	±0″.036

From these means the yearly residuals were found, and as given by Ambronn are tabulated below.

Table V.

YEAR.	SCHUR.	AMBRONN.	MEAN.
1890	—0″.10	—0″.08	—0″.09
1891	+0″.03	—0″.11	—0″.04
1892	+0″.09	—0″.08	0″.00
1893	+0″.10	+0″.06	+0″.08
1894	+0″.10	+0″.11	+0″.10
1895	—0″.04	+0″.25	+0″.10

Table V, continued.

YEAR.	SCHUR.	AMBRONN.	MEAN.
1896	−0″.10	+0″.12	+0″.01
1897	−0″.06	−0″.12	−0″.09
1898	+0″.01	−0″.08	−0″.04
1899	+0″.05	−0″.06	0″.00
1900	0″.00	+0″.02	+0″.01
1901	—	+0″.03	—
1902	—	+0″.09	—

A simple inspection of these figures shows a certain periodicity. This is shown in the series of each observer and in the series of means. The periodic time of these variations is somewhere between six and eight years, and the amplitude about 0″.1. The large residual (0″.25) for the year 1895 is considered by Ambronn to be due to purely personal or accidental causes.

Ambronn further compares the curves which represent the above series of residuals with Wolfer's sun-spot curve for the corresponding years. This curve, together with the above series of residuals, shows clearly, according to Ambronn, that there is no relation between the observed variations in the sun's diameter and the relative frequency of sun-spots.

In considering these results of Ambronn, we note that he investigates the possible variation in the average or *mean* diameter of the sun. The above residuals and the corresponding points on his curves are found by taking, in the series under consideration, the mean for each year of all the observations of both the polar and equatorial diameters. Thus his investigation would show whether there had been any change, periodic or secular, in the volume of the sun, and not whether there had been any change in either the polar or the equatorial diameter. Changes in the relative sizes of the diameters of the sun, or changes in its shape which do not alter its volume, could not be discovered by the methods used by Ambronn in this portion of his paper. His conclusions show that, during the entire period of nearly thirteen years, there was not present any periodic or secular variation in the sun's volume larger than that represented by a change of 0″.1 in the mean diameter of that body.

A comparison of the final values of the sun's diameter as found by Schur and Ambronn, with that found by Auwers from the transit of Venus observations, shows the new values to be considerably larger; but this difference is attributed to instrumental and personal peculiarities. The aperture of the objective, the color and density of the shade-glass used, — each has its effect on the measured diameter. The insertion of a prism in the Repsold heliometer reduced the apparent diameter by 0″.4. The earlier observations of Schur and Ambronn, as given by Auwers, were

Schur	1919″.52
Ambronn	1919″.26

But at the time of these observations other observers made the diameter vary between the limits

1920″.29 and 1918″38.

and Auswers found systematic errors depending upon the instrument used.

PART II. PHOTOGRAPHIC MEASURES.

The following investigation of the figure of the sun was suggested by the number of solar photographs taken by Lewis M. Rutherfurd in his private observatory, and by him presented to the Observatory of Columbia University. In a series of investigations of the Rutherfurd star plates, Jacoby has shown that the plates have suffered no deterioration, and that they are capable of giving results comparable in accuracy with the best heliometer determinations. It was hoped, therefore, that the Rutherfurd photographs of the sun would serve to determine with great precision the shape of that body, and in 1905 the writer undertook the measurement and reduction of all the Rutherfurd plates.

After the investigation was well under way and some preliminary results were obtained, it was decided to enlarge the scope of the investigation so as to include all available photographs. Unfortunately it was soon found that the number of suitable photographs is very limited. While several observatories have long series of solar photographs, yet in nearly every case these were taken with a horizontal telescope and without the necessary precautions to secure an edge sufficiently sharp for measurement. The mirror of horizontal instruments introduces errors and makes the solar image unsymmetrical. Only such plates as have been made with an equatorially mounted objective of relatively long focus can be used, and there are no long series of such plates.

Direct photographs of the sun's disk serve to determine the shape of that body, but cannot well be used to determine its absolute diameter. Changes in temperature affecting the focal length of the objective cause variations in the scale of the photographs. In stellar photography the scale of each plate is determined from measures of known stars whose images are found on that plate; in solar photography the plates do not contain data sufficient to find the scale value. The relative lengths of the various diameters can, however, be most accurately measured, and the shape, and variations in the shape, of the disk determined.

RUTHERFURD PLATES.

The Observatory of Columbia University has in its possession a series of 139 solar photographs taken by Rutherfurd during the years 1860–74. This series of plates may be divided into two groups; one group of plates covering the years 1860–66, and a second group taken during the years 1870–74. The plates of the first series were made with a small lens; those of the second group, with his thirteen-inch photographic objective, which was completed in 1868. The earlier plates were simple photographs of the sun without orientation-marks or data of any kind. In 1870 he began to place orientation-marks on the plates, but even after that date fully half of the plates lack this essential. In these four years, Rutherfurd took a hundred plates, grouped as follows:

1870, Feb. 16—Oct. 14	61 plates
1871, April 17—Aug. 19	14 "
1872, Jan. 2—Nov. 27	13 "
1874, April 5—Dec. 9	12 "
Total	100 plates

Of the sixty-one plates taken in 1870, only four were available for measurement, the remaining plates not having sufficient data to orient them. These four plates were rejected in the preliminary investigation, but were afterwards measured, and found to give satisfactory results.

Of the fourteen plates taken in 1871, eight were found to be measurable. A ninth plate was measured, but the measures were so discordant that it was rejected. The remaining five plates were either poorly developed or did not have orientation-marks upon them.

Of the thirteen plates taken in 1872, ten were found to be measurable. An eleventh plate was discarded after measurement, the separate measures being very discordant.

Of the twelve plates taken in 1874, only one had on it the full data for orientation. This was a very poor plate and was discarded after an attempt to measure it.

This left available for measurement a series of twenty-two plates, of which four were taken in 1870, eight in the spring and summer of 1871, and ten in the spring and summer of 1872. The measures were all made on the Repsold measuring-machine of Columbia University, and all measures were made in duplicate by Miss Harpham and Miss Davis of the Observatory computing staff. On each plate twenty-eight points on the sun's limb were measured,— seven points at or near each pole, and seven points at or near each extremity of the equator. In each of these four groups the separate points were five degrees apart, each group thus covering an arc of 30°, or 15° on each side of the pole or equator respectively. The measurement of each point consisted in the determination of its polar co-ordinates, position angle and distance, as referred to the center of revolution of the plate in the machine. This center of revolution does not coincide with the center of the sun's disk, but the plates can be quite accurately adjusted in the machine. In no case did the center of revolution differ from the true center of the disk by more than 0.05 mm. or 1″.2.

The measures were corrected for differential refraction, the formulas as given by Chauvenet being used. From these corrected measures were then found the co-ordinates of the center of the sun and the most probable value of the sun's radius. The measured co-ordinates were then transferred from the center of revolution to the center of the sun's disk as origin; and thus were found, for each plate, the values of twenty-eight radii of the sun.

The mean of the fourteen polar radii, as thus found, for each plate, was taken as the value of the polar radius; and the mean of the fourteen equatorial radii, as the value of the equatorial radius for that plate. The difference between these values of the polar and equatorial radii was then formed, in the sense polar minus equatorial, and the results for the various plates are exhibited in the following tables:

Table VI.

1870.

DATE.	P.-E. (ARC).	WT.
Aug. 18	+0″.49 ±0″.28	2.4
Sept. 24	—0″.12 ±0″.31	2.0
Sept. 28	+0″.81 ±0″.25	3.0
Oct. 5	+0″.60 ±0″.26	2.9

Table VI, continued.

1871.

Date.	P.-E. (arc).	Wt.
April 21	−0″.63 ±0″.36	1.8
June 16	−0″.18 ±0″.22	5.6
July 16	−0″.68 ±0″.19	6.7
July 20	−0″.67 ±0″.35	1.6
July 21	−0″.72 ±0″.30	2.4
July 22	−1″.00 ±0″.30	2.4
Aug. 12	+0″.04 ±0″.21	7.1
Aug. 19	+0″.36 ±0″.20	5.0

1872.

Date.	P.-E. (arc).	Wt.
May 7	+0″.30 ±0″.17	10.0
May 10	+0″.45 ±0″.23	5.3
May 27	+0″.32 ±0″.27	2.3
June 15	+0″.48 ±0″.29	2.5
June 29	+0″.40 ±0″.27	3.0
July 6	+0″.77 ±0″.33	1.8
July 17	+0″.36 ±0″.22	5.9
Aug. 10	−0″.21 ±0″.14	14.3
Aug. 12	+0″.32 ±0″.33	2.0
Sept. 21	+0″.49 ±0″.30	2.5

In the above tables the first column gives the date on which the plate was taken; the second and third columns give the difference between the polar and equatorial radii in arc, together with the mean error of this result as determined from the separate measures; the third and last column gives the relative weights of the different plates as determined from their mean errors. The scale value differed for each plate, and was determined by assuming that the value of the mean radius of the sun at distance unity is equal to 961″. Approximately one division of the scale is equal to 24″.6 of arc.

The different plates in each year give quite consistent results, but the

UOFM

mean results for the different years differ radically. The plates in 1871 show the equatorial radius to exceed the polar by some 0″.3; while the plates of 1870 and 1872, on the other hand, show the polar radius to be the greater by some 0″.2. Forming the mean by weights of the results obtained from the plates in the different years, we see that the yearly means are as follows:

1870, Sept. 22	+0″.50±0″.10
1871, July 19	—0″.32±0″.16
1872, July 2	+0″.22±0″.09

These measures thus seem to indicate a change in the relative sizes of the polar and equatorial radii of the sun. During the interval 1871–72, the polar radius was increasing relatively to the equatorial, and by 1872 was decidedly the greater. These changes in the shape of the sun are apparently real changes, and can hardly be accounted for in any other way. The plates were all taken with the same instrument and under the same conditions, and in corresponding seasons of the year. They were nearly all taken in the morning hours and at approximately the same distance from the meridian. So far as can be determined from the data at hand, there is no instrumental explanation for the difference between the results in the different years.

The conclusion from this investigation is, that during this period, 1870–72, there was a real change in the shape of the sun; the equatorial diameter first increasing and then shrinking relatively to the polar diameter.

Forming the mean by weights of the entire series, it is found that during the years 1870–72 the polar radius exceeded the equatorial by

P.–E. = —0″.06.

NORTHFIELD PLATES.

Under the direction of Professor W. W. Payne, Dr. H. C. Wilson has taken a long series of solar photographs at Northfield, Minn. Only a few of these photographs are available for measurement. Dr. Wilson selected and sent to Columbia University for measurement nine plates, which were taken during the years 1893 and 1894, all of which were well oriented and had on them the necessary data for measurement and reduction.

These nine plates were measured in the same manner as were the Rutherfurd plates, with the following results:

Table VII.

1893.

Date.	P.-E. (arc).		Wt.
Sept. 8	—1″.10	±0″.24	2.8
Sept. 9	—0″.94	±0″.21	3.7
Sept. 11	—0″.72	±0″.18	5.9
Sept. 20	—1″.60	±0″.25	2.5
Sept. 21	—0″.76	±0″.33	1.5
Sept. 27	—0″.70	±0″.30	1.8
Sept. 28	—0″.41	±0″.29	1.9

1894.

Date.	P.-E. (arc).		Wt.
July 10	—0″.72	±0″.24	3.3
July 17	+0″.36	±0″.31	3.1

Forming the mean by weights of the entire series, it is seen that, during the years 1893–94, the equatorial radius was the greater, exceeding the polar by

P.-E.= —0″.72.

YERKES PLATES — THE PHOTO-HELIOMETER.

In the latter part of 1896 a six-inch lens of forty feet focal length was mounted on the tube of the forty-inch Yerkes telescope. This lens was made by Brashear and was specially designed and corrected for photographic work. With it a long series of experiments were carried out and many photographs taken. These experiments were undertaken with the view of determining the best methods of applying photography to the determination of the size and shape of the sun. While the photographs obtained can only be regarded as experimental, yet they lead to definite conclusions as to the value of this method and as to its possibilities.

This investigation of photographic methods led to experiments with a photographic heliometer, and early in 1907 the six-inch was dismounted and a pair of two-inch photographically corrected lenses of twenty-five feet focal length were mounted side by side in the same cell, so as to give overlapping images of the sun. The cell was arranged so as to revolve about the collimation axis in a manner similar to the cell of a heliometer. Thus the line joining the centers of the two lenses could readily be placed parallel to the equatorial or to the polar diameter of the sun. The apparatus was attached to the great forty-inch Yerkes telescope and a series of photographs taken by Mr. Fox. On each day a set of two photographs was taken, one of the polar and one of the equatorial diameters. As a rule these two exposures were made within three or four minutes of each other.

On each photograph the length of the chord common to the two images is a measure of the radius passing through the extremity of the chord. This chord furnishes an accurate measure of the radius, for slight changes in the radius produce large changes in the chord. A given change, Δ r, in the radius will produce a change, Δ d, in chord approximately equal to

$$\Delta d = \frac{r}{d} \Delta r$$

where r and d are the respective lengths of the radius and the chord. If, therefore, the chord be one-third the radius, then a change of only 0″.3 in the radius will produce a change of 1″ in the chord. As the scale of the photographs is such that one millimeter is approximately equal to 27″, changes of 0″.10 in the radius would under these circumstances produce changes of 0.01 mm. in the chord; and on good photographs quantities of this size can be readily measured.

On the test photographs made at Yerkes, the image at distance unity was 71 mm. in diameter and the chord 32 mm. long. When, therefore, the line joining the centers of the lenses was parallel to the equator of the sun, the radii passing through the extremities of the chord were inclined 26° to the equator; and similarly, in the reversed position of the objective, the measured radii made angles of 26° with the axis of the sun. In other words, the radii as measured on the equatorial and polar plates cut the surface of the sun in latitudes 26° and 64° respectively. The results reduced to distance unity for these test plates are shown below.

Table VIII.

Date.	Mean Radius.	Residuals.		P.-E.
		mm.	arc.	arc.
Oct. 18	35.538	+033	+0″.89	—0″.81
Oct. 21	35.469	—036	—0″.97	—1″.16
Oct. 22	35.497	—008	—0″.22	—1″.43
Oct. 23	35.536	+031	+0″.84	—1″.08
Nov. 18	35.469	—036	—0″.97	—0″.62
Nov. 12	35.521	+016	+0″.43	—0″.57
Means	35.505			—0″.95

These results are fairly accordant, and indicate that at this time the radius passing through latitude 26° exceeded that passing through latitude 64° by nearly one second of arc. The plates, however, were few in number; but they show, at least, the value of the method, and confirm to some slight degree the non-spherical shape of the sun.

The photographic tests made at the Yerkes Observatory established the value of the photographic method and of the photo-heliometer; but they showed conclusively that, in order to obtain satisfactory plates, two essentials must be observed.

1. The photographic lens must be carried on a separate and specially designed equatorial mounting, so constructed that the shutter is independent of the mounting. If attached to the mounting, the shutter will almost invariably cause jars and consequent distortions of the image.
2. Wet plates should be used. On the modern rapid dry plates the edges of the image are not sufficiently sharp for accurate measurement.

PART III. DISCUSSION OF OBSERVATIONS AND RESULTS.

THE FIGURE OF THE SUN.

A NEW TABULATION OF THE GERMAN HELIOMETER MEASURES. — In the investigation of the general subject of the figure and the possible variations in the size and shape of the sun, the writer was led to a re-discussion, or rather to a re-tabulation, of the results obtained by Auwers from the transit of Venus observations.

In forming his means from which the heretofore given result was obtained, Auwers kept together all observations made with a single instrument, and thus observations of different years were grouped together. As arranged by Auwers, these observations do not afford any indication of a change of the relative diameters with the time. In order to investigate this point, I re-arranged the series of observations as given by Auwers, arranging them in order of the time without regard to the observer or the instrument. When thus arranged, the observations fall into two series: one extending from September, 1873, to January, 1875; the other, from May, 1880, to June, 1883. There is an isolated observation in July, 1877, another isolated one in March, 1884, and two short series in the latter part of 1884 and the beginning of 1885.

There is an uncertainty of some days in assigning a date to each determination of the ratio of the solar diameters; for the value of the difference between the polar and equatorial diameters (P.–E.), as given by Auwers for each observer, is found by him as the mean result of a number of observations, extending in many instances over a period of a month or more. In very few cases did an observer measure the polar and equatorial diameters on the same day, nor is the number of polar and equatorial diameters the same in any series. In reducing the observations of any one observer, Auwers took the mean of all diameters measured within 15° of the poles, and called such mean the polar diameter. He similarly took the mean of all diameters measured within 15° of the equator, and called such mean the equatorial diameter. The mean dates to which these mean diameters belong are not given by Auwers. For example, the observations made by Adolph in Strassburg were all made on fifteen days between Sept. 2 and Sept. 25, 1873. In this series Adolph made in all some fifty-seven determinations of the sun's diameter; of which fifty-seven measures ten fall within the 15° limit of the pole, and nine within the corresponding limit of the equator. The polar measures were made on Sept. 8, 14, 18 and 21; the equatorial measures, on Sept. 18, 20, 21, 23 and 25. The remaining thirty-eight observations of this series were not utilized by Auwers in this investigation.

As a result of these nineteen measures by Adolph, Auwers finds the value for the ratio between the polar and equatorial diameters —0″.16, in the sense polar minus equatorial; and this value, I have assumed, is the value for Sept. 18, the mean date of the observations. Such an assumption is, of course, more or less approximate, but it gives a date sufficiently close for the purpose in hand.

SERIES OF 1873–75. — In the first series of observations, extending from 1873 to 1875, there are in all thirteen such sets of observations. These are tabulated below, being arranged according to the mean dates of the observations, the weights being those assigned by Auwers.

Table IX.

DATE.	OBSERVER.	P.-E.	WEIGHT
1873, Sept. 18	Adolph	—0″.16	0.5
1873, Sept. 20	Borgen	+0″.03	0.5
1873, Oct. 20	Valentiner	—0″.21	0.5
1873, Dec. 15	Wittstein	+0″.05	1.0
1874, Feb. 4	Weinek	+0″.15	0.8
1874, March 18	Schur	+0″.09	0.2
1874, April 3	Adolph	—0″.32	0.2
1874, May 15	Schur	+0″.15	1.0
1874, Dec. 26	Adolph	+0″.16	1.7
1874, Dec. 28	Borgen	+0″.21	0.1
1874, Dec. 29	Valentiner	+0″.23	0.2
1875, Jan. 5	Schur	+0″.44	0.4
1875, Jan. 5	Seeliger	+0″.13	0.2

While the separate determinations vary, a simple inspection of the above table shows that there was a progressive change in the difference between the polar and equatorial diameters. In the earlier measures the equatorial diameter was slightly the greater; in the later measures the polar diameter was decidedly the larger. This is shown not only by the average result, but by the measures of each observer. Adolph, Borgen, Valentiner and Schur made observations in the fall of 1873 and the spring of 1874; again, these same observers made other series of observations in the latter part of 1874 and in January, 1875. In the case of each of these four observers, the difference, P.-E., is greater in the latter series. These results are shown in the following table:

OBSERVER.	1873-74.	1874-75.
Adolph	—0".20	+0".16
Borgen	+0".03	+0".21
Valentiner	—0".21	+0".23
Schur	+0".14	+0".44

Again, divide the entire series of observations into three groups, placing in the first group all the observations made in 1873, in the second group those made in the spring of 1874, and in the third group those made in December, 1874, and in January, 1875. Give to each observer the weight assigned by Auwers, and form the weighted mean of each of the three groups. The observations then fall into the following order:

MEAN DATE.	P.-E.	WEIGHT.
1873, October	—0".06	2.5
1874, March	+0".10	2.2
1874, December	+0".21	2.6

And these means show the same progressive change as do the observations of the separate observers.

SERIES OF 1880-85.— In this series there are in all thirty-two sets of observations, of which number, however, twenty-three were made in 1882. These are tabulated in Table X, being arranged according to the date of observation in a manner entirely similar to the former table for 1873-75.

Table X.

DATE.	OBSERVER.	P.-E.	WEIGHT.
1880, May 9	Ambronn	+0″.19	1.1
1880, July 15	Ambronn	+0″.08	4.0
1881, Sept. 30	Franz	—0″.51	0.3
1881, Nov. 10	Schur	+0″.22	2.8
1882, March 14	Kobold	+0″.28	0.5
1882, March 25	Peter	+0″.06	5.0
1882, March 28	Müller	+0″.37	0.5
1882, April 4	Kobold	—0″.05	2.8
1882, April 6	Marcuse	+0″.07	0.7
1882, April 15	Küstner	.00	0.4
1882, April 15	Kempf	+0″.09	1.7
1882, May 3	Deichmüller	—0″.04	4.0
1882, May 15	Hartwig	+0″.09	6.2
1882, May 15	Schur	+0″.13	4.0
1882, May 22	Franz	+0″.06	0.5
1882, June 4	Wislicenus	+0″.02	4.0
1882, July 2	Bauschinger	—0″.05	1.7
1882, Nov. 20	Franz	—0″.06	1.0
1882, Nov. 25	Küstner	+0″.13	1.3
1882, Nov. 25	Kobold	—0″.01	1.7
1882, Nov. 30	Deichmüller	—0″.30	0.1
1882, Nov. 30	Müller	—0″.34	0.2
1882, Nov. 30	Auwers	—0″.01	1.7
1882, Dec. 2	Wislicenus	—0″.28	0.3
1882, Dec. 4	Peter	+0″.15	0.5
1882, Dec. 5	Kempf	+0″.32	0.6
1882, Dec. 5	Hartwig	+0″.30	0.7
1883, May 15	Wislicenus	—0″.21	6.2
1883, June 4	Hartwig	—0″.02	2.8
1884, March 17	Marcuse	+0″.28	0.3
1885, Jan. 7	Kobold	+0″.14	0.3
1885, Jan. 16	Battermann	—0″.48	0.3

An inspection of these results will again show a change in the difference between the polar and equatorial diameters. This change is not at once apparent, for the relative weights of the separate determinations in this series differ greatly, the largest being 6.2, the smallest 0.1. Some of the determinations of small weight differ considerably from adjacent and better observations, and these poor values tend to conceal the progressive change in the ratio between the diameters. This change, however, is clearly brought out when the observations are divided into groups and the weighted means of each group formed. When this is done, we find that the observations arrange themselves as in the following table:

DATE.	P.-E.	WEIGHT.
1880, June	+0″.10	5.1
1881, October	+0″.11	3.1
1882, March	+0″.06	11.6
1882, June	+0″.05	20.4
1882, November	+0″.05	8.1
1883, May	—0″.15	9.0
1884, March	+0″.28	0.3
1885, January	—0″.17	0.6

We thus see that during the interval from 1881 to 1883 there is a progressive change; the equatorial diameter apparently growing longer in relation to the polar diameter. While the division of the observations of the year 1882 into three groups is more or less arbitrary, yet, no matter how these observations had been grouped, the progressive character of the change would have been apparent. The mean of all the determinations for the year 1882 is + 0″.05 with a weight of 40.1.

TABULATION OF RESULTS. — Collecting the results of the various determinations into a single table, we have the following data from which to determine the shape of the sun. In this table the measures are all reduced to the same form, and give the excess in arc of the polar radius over the equatorial. For convenience of comparison the series of Auwers and Ambronn are separated into groups, the observations of various years or series of years being collected together.

Table XI.

MERIDIAN OBSERVATIONS.

Date.	*Observer.*	*P.-E.*
1809	Von Lindenau	+5″.0
1831	Bianchi	—3″.0
1871	Secchi	—0″.8
1885	Auwers	—0″.2

HELIOMETER OBSERVATIONS.

Date.	*Observer.*	*Series*	*P.-E.*	
1891	Auwers	1873–75	+0″.05	+0″.019
1891	Auwers	1880–82	+0″.03	
1891	Auwers	1883–85	—0″.01	
1905	Ambronn	1890–91	+0″.05	+0″.013
1905	Ambronn	1893–94	—0″.02	
1905	Ambronn	1894–00	+0″.01	

CONCLUSIONS. — While very little weight can be attached to the meridian observations, yet every series shows a measurable departure from the spherical form. The observations of the Von Lindenau series were afterwards included in the more complete and thorough discussion of Auwers, who showed that the great difference, 5″, found by Lindenau was not warranted by the observations. Meridian observations are unsuitable for the investigation, and if there be any departure of the sun from sphericity, it is below the limit of such measures.

The heliometer measures confirm the result that the departure from sphericity is extremely small, but they hardly warrant the assumption that the sun is a sphere. Auwers, Ambronn, Seeliger and Wellmann have shown that the measured diameters depend upon the color and thickness of the shade-glasses used in the observations; Auwers found instrumental peculiarities, different instruments giving different results; and Ambronn found that the introduction of a reflecting prism diminished the measured diameter by 0″.4. The series of observations used by Auwers were extremely heterogeneous, twenty-three observers using five heliometers. The individual series were short, extending over periods of a few months only. The series of Ambronn, on the other hand, are perfectly homogeneous, and they furnish the very best evidence yet obtained. They indicate that the departure of the sun from spherical form is extremely minute, and at the very limit of possible measurement by these means. Considering this series by itself, if no weight be placed upon possible variations in the solar diameter, then the conclusion must be that the sun is sensibly a sphere.

Unfortunately for a thorough test of the photographic method, no long series of plates were available. While several observatories have for many years photographed the sun on each clear day, yet these photographs are not suitable for the present investigation.[1] They were mostly made with horizontal instruments and no attention paid to sharpness of edge. The mirror of such instruments introduces errors and makes the image unsymmetrical. Only such plates as have been made with an equatorially mounted objective of relatively long focus can be used, and there are no long series of such plates. The early plates of Rutherfurd give quite consistent results, the general mean of all the plates agreeing closely with that of Auwers as found from the heliometer measures in the same years. These plates of Rutherfurd were made on collodion films and give the sharpest and best images of any plates measured.

---

[1] This applies to American observatories. The photographs taken at the Royal Observatory at Greenwich are probably well adapted for this investigation.

In 1893–94 the plates by Wilson give a result having the same sign as Ambronn's mean for these same years. The photographic result, however, is very much larger. The photo-heliometer promises to give accurate results; and a forty-foot instrument of this character should finally decide the question as to the shape of the sun.

The only conclusion that can safely be drawn from the conflicting data is, that the exact shape of the sun is not known with certainty. On the average, it approximates very closely to a sphere; the difference between the equatorial and polar radii, if such difference exists, being probably not more than 0″.25. The heliometer measures show marked variations in the different years, and a part of the conflict in the results may be due to actual variations in the shape and size of the sun.

VARIABILITY OF THE SUN'S DIAMETER.

The following table exhibits the results of the various investigations mentioned in the first part of this paper.

Table XII.

	MERIDIAN OBSERVATIONS.
1809 *Lindenau*	Periodic variations.
1809 *Lindenau*	Re-discussed 1889 by Auwers — no variations.
1871 *Secchi*	Varies inversely with the number of sun-spots.
1871 *Secchi*	Re-discussed 1885 by Auwers — no variations.
1874 *Newcomb & Holden*	No long-term variation.
1895 *Auwers*	1st discussion — varies with number of sun-spots.
1895 *Auwers*	2d discussion — observed variation due to variable personal equations.
	HELIOMETER OBSERVATIONS.
1905 *Ambronn*	Periodic variation of 0″.1, but no relation to sun-spot period.

These investigations dealt with possible variations in either the equatorial or polar diameter, as in Auwers' work, or in the average or mean diameter, as in Ambronn's paper. But the state of the atmosphere, the sharpness of the image, the color of the shade-glass used, — all these affect the measured diameter, and introduce accidental and semi-periodic errors. Any actual variations in the diameter will, therefore, be masked by these errors of observation, and correspondingly difficult to determine. On the other hand, if there be a variation in the sun's diameter, it is improbable that such variation affects both the polar and equatorial diameters in the same way. The measured differences between the two diameters is thus more likely to show the presence of a variation than will the direct measures of either diameter by itself. Again, when both diameters are measured on the same day, both are affected by the errors due to atmospheric conditions and to instrumental peculiarities. Measures of the differences of the diameters are, therefore, to a large extent, free from the troubles which mark the measures of each diameter itself, and such measures furnish the best test for possible variations in the sun.

For such an investigation the observations of Schur and Ambronn provide material, for on each day of observation during twelve years, they measured both equatorial and polar diameters. The transit of Venus heliometer measures, as reduced by Auwers, are not so satisfactory; for the polar and equatorial measures were not made on the same days. In each series used by Auwers, the measures of the respective diameters were scattered irregularly, only a few days, however, separating the individual measures; and the mean results should be more free from the masking errors due to atmospheric conditions than simple determinations of either diameter. Such measures should be free from instrumental peculiarities and the effects of different colored shade-glasses.

FLUCTUATIONS HAVING THE SAME PERIOD AS THE SUN-SPOTS. — The writer proposes to investigate possible variations in the sun, using the difference of diameters (polar-equatorial) as given in the works of Auwers and Ambronn. The method of equations of condition as elaborated by Newcomb will be used; and for the purpose of forming such equations it will be assumed that the difference between the diameters (P.–E.) fluctuates harmonically in a period of 11.13 years. This is the mean sun-spot period as determined by Newcomb, and if there be any variation in the shape of the sun, it is just as likely to follow this rigorous period as to follow any arbitrary system of numbers based upon the actual number and size of spots visible at a given time.

This assumption may be represented by an equation of the form

$$\text{P--E} = \rho \cos(\mu t + \text{C}) + z$$

where μ is so taken that the angle $\mu t + \text{C}$ shall increase by 360° in the sun-spot period of 11.13 years. When the year is the unit of time, this gives

$$\mu = 32^\circ.25.$$

The constant C determines the phase at the epoch from which it is measured. This epoch is arbitrary, and in the present investigation will be taken as 1889.12, corresponding to a sun-spot minimum.

Expanding the cosine term, the above expression can be put into the form

$$n = x \cos \mu t + y \sin \mu t + z$$

where

$$x=\rho \cos C$$
$$y=-\rho \sin C$$
$$n=P-E.$$

If, now, we write

$$a=\cos \mu t$$
$$b=\sin \mu t$$

the equation of condition becomes finally

$$ax+by+z=n.$$

The yearly values of the quantity P.-E. are taken from the results of Auwers and Ambronn as given in the previous tables. The values of the coëfficients a and b can be readily computed for each year from the corresponding value of μ. The resulting equations of condition are given in the following table:

Table XIII.

DATE.	OBSERVER.	a.	b.	n.
1873, October	Auwers	—0.7	—0.7	—0″.06
1874, March	Auwers	—0.5	—0.8	+0″.10
1875, January	Auwers	—0.1	—1.0	+0″.21
1880, June	Auwers	+0.1	+1.0	+0″.10
1881, October	Auwers	—0.5	+0.8	+0″.11
1882, July	Auwers	—0.8	+0.6	+0″.05
1883, June	Auwers	—1.0	0	—0″.15
1885, January	Auwers	—0.6	—0.8	—0″.17
1890, July	Ambronn	+0.7	+0.7	+0″.12
1891, July	Ambronn	+0.2	+1.0	+0″.08
1892, January	Ambronn	—0.3	+0.9	0″.00
1893, July	Ambronn	—0.8	+0.6	—0″.06
1894, July	Ambronn	—1.0	+0.1	+0″.02
1895, July	Ambronn	—0.9	—0.4	+0″.04
1896, July	Ambronn	—0.5	—0.9	—0″.03
1897, July	Ambronn	0	—1.0	—0″.01
1898, July	Ambronn	+0.5	—0.8	+0″.09
1899, July	Ambronn	+0.9	—0.4	+0″.01
1900, July	Ambronn	+1.0	+0.1	+0″.02
1901, July	Ambronn	+0.8	+0.7	+0″.06
1902, July	Ambronn	+0.3	+1.0	—0″.06

Three least square solutions were made, the first including the Auwers series 1873–85; the second, the Ambronn series, 1890–1902, and the third, the entire series of heliometer measures from 1873 to 1902. The results of these three solutions are shown below:

SERIES.	x.	y.	z.
1873–85	$+0''.255$	$+0''.015$	$+0''.156$
1890–02	$+0''.032$	$+0''.001$	$+0''.019$
1873–02	$+0''.048$	$+0''.006$	$+0''.029$

The probable error for x in the whole series is $\pm$ $0''.021$. Thus the value of x as found from the equations is slightly more than twice its probable error. Moreover, in each series the three quantities come out with the same sign and approximately of the same relative values. Reducing the results to monomials, we have finally for the three determinations

$$\begin{aligned} \text{P.–E.} &= +0''.256 \cos (\mu t-4^\circ)+0''.156 && \text{series of 1873–85.} \\ &= +0''.032 \cos (\mu t-2^\circ)+0''.019 && \text{series of 1890–02.} \\ &= +0''.049 \cos (\mu t-6^\circ)+0''.029 && \text{series of 1873–02.} \end{aligned}$$

These results were obtained by assuming a harmonic variation having a period of 11.13 years. They show that the phases of such a variation coincide to within one-fifth of a year with the phases of the sun-spot fluctuations; that, at times corresponding to minimum of sun-spottedness, the polar diameter is relatively larger; that, at times of maximun sun-spottedness, the equatorial diameter is relatively larger.

The amplitude of the variation is extremely small, but its reality would seem to be established. The present investigation at least renders the existence of such periodic fluctuations in the shape of the sun more probable than their non-existence.

SEARCH FOR SHORT-TERM PERIODIC VARIATIONS. — If the equator of the sun were of permanent elliptic shape, then we should have a periodic variation in the observed differences between the polar and equatorial diameters, and the period of this variation would be equal to the sun's synodic rotation. While it is extremely improbable that any such permanent deformation exists, yet semi-permanent deformations may readily occur. The sun-spots are local phenomena; and when large spots exist on one portion of the surface, the equator may be deformed in such regions, and such deformation may persist during many rotations of the sun.

Unfortunately for investigating the question of the existence or nonexistence of fluctuations in the measured shape of the sun, corresponding to possible deformations of the equator, the sun's synodic rotation is not a well defined constant. Different portions of the surface rotate in different periods. According to the latest spectroscopic researches, the equatorial regions rotate in 24.46 days, and regions in latitude 80°, in 30.56 days.

The corresponding synodic periods are 26.92 and 33.35 days respectively. Sun-spot observations give 27.25 days for the synodic period. This uncertainty in the period prevents us from using the method of equations of condition, similar to that used in investigating the fluctuations corresponding in period to the sun-spot cycle. But Newcomb[1] has lately developed a method, which he calls the "method of time-correlation," by which the fluctuations in any measured quantity can be investigated and the existence of or tendency towards periodic variations detected. This method may be briefly outlined as follows.

Suppose we have a series of values of a measured quantity for equidistant intervals of time,

$$t,\ 2t,\ 3t,\ \text{etc.}$$

and let

$$a_0,\ a_1,\ a_2,\ a_3\ \ .\ .\ .\ .\ .\ .\ \ a_n$$

be the departures of these values from the general mean. Now multiply each one of these residuals in turn by the first residual, a_0, so that we have the products

$$a_0a_0,\quad a_0a_1,\quad a_0a_2\ \ .\ .\ .\ .\ .\ .\ .\ \ a_0a_5.$$

If these residuals be purely periodic, having for a period some multiple of t greater than 2, then these products will fall into a rhythmical series. The first product and the product corresponding to the end of the period will both be positive; the intermediate products, positive or negative. If we form a similar series of products by multiplying the second and each succeeding one by the second residual, then these products will again fall into a similar rhythmical series. Continuing the process we should have the following:

$$\begin{array}{lcccccc}
 & a_0a_0 & a_0a_1 & a_0a_2 & .\ .\ .\ .\ .\ .\ . & a_0a_4 \\
 & a_1a_1 & a_1a_2 & a_1a_3 & .\ .\ .\ .\ .\ .\ . & a_1a_5 \\
 & a_2a_2 & a_2a_3 & a_2a_4 & .\ .\ .\ .\ .\ .\ . & a_2a_6 \\
 & | & | & | & & | \\ \hline
\text{Sums} & [a_0a_0] & [a_0a_1] & [a_0a_2] & & [a_0a_4]
\end{array}$$

If, now, the period in which the residuals repeat be 4t, then the first and fifth products will in every series be positive, and therefore the sums of these products, $[a_0\,a_0]$ and $[a_0\,a_4]$, will be positive. The intermediate sums will be positive or negative and the whole series of sums will form a rhythmical curve.

---

[1] A Search for Fluctuations in the Sun's Thermal Radiation through their Influence on Terrestrial Temperature (American Phil. Society, N. S., Vol. XXI, Part V).

Even if the purely accidental errors of the observations be so large as to mask completely the periodic character of the residuals, yet the effects of these errors will be largely eliminated in forming the products and taking the sums, and the final sums will form a rhythmical curve. Instead of using these sums directly, Newcomb finds the ratio of each sum to the first, $[a_0\, a_0]$, and calls these successive ratios x_1, x_2, x_3, etc., so that

$$x_i = \frac{[a_0 a_i]}{[a_0 a_0]}$$

where $i = 1, 2, 3$, etc.

Now if the observations be periodic, or if there be a tendency toward a rhythmical deviation whose period is approximately a multiple of t, then such period or tendency will be shown by an increasing value of x at the time corresponding most nearly to the completion of the period. If there be no tendency toward any period between 2t and nt, then the series of x's should converge toward zero.

This method was used in an investigation of the observations of the difference between the polar and equatorial diameters of the sun as made by Schur and Ambronn during the years 1892–1902. As has been noted, the general mean of all of Schur's observations made during the period was $+ 0''.018$, while that of Ambronn was only $+ 0''.002$. In the case of Schur, therefore, the residuals found by subtracting this mean $(+ 0''.02)$ from each observation were used instead of the observations themselves. In the case of Ambronn, the mean being so nearly zero, the observations were used directly. The whole series of observations was then divided into consecutive periods of seven days, and the mean residual for each period found. In all there were 654 such seven-day periods, out of which number seventy-one periods only contained observations by both observers. In eighteen periods, Schur had two or more observations, and in six periods Ambronn had two observations.

The series is disconnected; there are many periods in which no observations were made, and these periods are scattered irregularly throughout the series. The longest period in which consecutive observations were made was begun in May, 1899, when observations were made in eleven successive seven-day periods. In the entire series there are found only nine cases in which observations were made on six or more consecutive seven-day periods and which therefore could be used in the present investigation. In addition to these nine, two other sets were utilized, in one of which observations were made on thirty-nine weeks with but three or four breaks of single weeks; in the other set, observations were made on nineteen weeks with but three breaks.

To illustrate the method by which the periodicity was investigated, the tabulation for the longest series of consecutive observations is given in full. The first column gives the date of beginning of each of the seven-day periods into which the observations were divided. The second column gives the mean residual for the period as taken from Appendix IV of Ambronn's work. In the first period there were two observations by Schur and one by Ambronn; and the mean of the three, after subtracting + 0″.02 from each of Schur's, is — 0″.11. The remaining columns in the table give the successive products formed by multiplying a_0 into the successive residuals. The products of the first a_0 (— 0.11) by itself and the following five residuals are found in the first horizontal line.

Table XIV.

DATE.	a_0	a_0a_0	a_0a_1	a_0a_2	a_0a_3	a_0a_4	a_0a_5
1899, May, 29	—0.11	+0.0121	+0.0209	—0.0011	+0.0066	+0.0088	—0.0341
1899, June, 5	—0.19	+0.0361	—0.0019	+0.0114	+0.0152	—0.0589	0.0000
1899, June, 12	+0.01	+0.0001	—0.0006	—0.0008	+0.0031	0.0000	+0.0003
1899, June, 19	—0.06	+0.0036	+0.0048	—0.0186	0.0000	—0.0018	+0.0012
1899, June, 26	—0.08	+0.0064	—0.0248	0.0000	—0.0024	+0.0016	—0.0328
1899, July, 3	+0.31	+0.0961	0.0000	+0.0093	—0.0062	+0.1271	+0.0465
1899, July, 10	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	
1899, July, 17	+0.03	+0.0009	—0.0006	+0.0123	+0.0045		
1899, July, 24	—0.02	+0.0004	—0.0082	—0.0030			
1899, July, 31	+0.41	+0.1681	+0.0615				
1899, Aug. 7	+0.15	+0.0225					
Sums		+0.3463	+0.0511	+0.0095	+0.0208	+0.0768	—0.0189
x_1			+0.1476	+0.0274	+0.0601	+0.2218	—0.0546

Each column of the table is summed up and the bottom line gives the cœfficients of correlation x_1, found by dividing the footings of the last five columns by the sum of the $a_0\,a_0$'s.

The values of x thus found are distinctly periodic. There is a marked increase in the third and fourth values, and this indicates a tendency towards a period of approximately twenty-eight days. The series, however, is too short for any definite conclusion, and considered by itself this series would have but little weight in testing the actuality of this apparent periodicity.

The ten other series of observations were each tabulated and investigated for periodicity in the same manner. It does not seem necessary, however, to give the individual residuals and products in detail. But the following table gives the footing for each column of products in the different series, and shows the date of beginning and the number of seven-day periods in each.

Table XV.

DATE.	No.	a_0a_0	a_0a_1	a_0a_2	a_0a_3	a_0a_4	a_0a_5
1891, Feb. 16	7	+0.3262	+0.0812	+0.0602	+0.0887	—0.0040	—0.0174
1892, March 7	6	+0.1255	+0.0347	+0.0132	+0.0097	—0.0343	—0.0248
1895, April 29	6	+0.0563	+0.0114	—0.0181	—0.0079	—0.0026	—0.0105
1896, April 27	6	+0.7938	+0.0390	+0.1749	+0.2698	—0.0908	+0.0040
1897, April 19	10	+0.3557	—0.0352	—0.0393	—0.0547	+0.0293	—0.1033
1897, April 19	37*	+1.5752	—0.2549	—0.2903	—0.0217	+0.2213	—0.1859
1899, Jan. 23	9	+0.3446	+0.1257	+0.1269	—0.0255	—0.0275	—0.0801
1899, May 29	11	+0.3463	+0.0511	+0.0095	+0.0208	+0.0768	—0.0189
1900, Feb. 5	19*	+0.2688	+0.0063	—0.1188	+0.0543	+0.1251	—0.0138
1900, April 16	8	+0.0335	+0.0133	+0.0062	+0.0067	+0.0035	+0.0078
1901, April 15	8	+0.1022	—0.0026	+0.0038	—0.0444	—0.0019	—0.0062
Sums		+4.3281	+0.0700	—0.0718	+0.2958	+0.2949	—0.4491
x_1			+0.0162	—0.0166	+0.0683	+0.0681	—0.1038

The series of x's are again distinctly periodic, and indicate a tendency towards a twenty-eight-day period. This tendency is not only shown by the final series of x's, but it is also shown by nearly every one of the individual sets of footings as given in the above table. In six cases the increase is marked in the a_0 a_4'th column; in two cases, in the a_0 a_3'd column; and in one case, in the a_0 a_5'th column. Two series only show no tendency towards periodicity, and of these one is a short series of six weeks only, beginning March 7, 1892. The other series, which shows no periodicity, is the relatively long one beginning Jan. 23, 1899, and extending over nine weeks. On the whole, however, the tendency towards a recurrence at the end of approximately twenty-eight days is quite marked.

Continuing the products for the two long series up to a_0 a_8, we have for the series of products:

---

* Broken series.

Table XVI.

	1897 April 19.	1900 Feb. 5	Sums.	x_i.
a_0a_0	+1.5752	+0.2688	+1.8440	
a_0a_1	—0.2549	+0.0063	—0.2486	—0.1348
a_0a_2	—0.2903	—0.1188	—0.4091	—0.2219
a_0a_3	—0.0217	+0.0543	+0.0326	+0.0174
a_0a_4	+0.2213	+0.1251	+0.3464	+0.1878
a_0a_5	—0.1859	—0.0138	—0.1997	—0.1083
a_0a_6	—0.5121	—0.0470	—0.5591	—0.3032
a_0a_7	+0.0105	+0.0732	+0.0837	+0.0454
a_0a_8	+0.5543	+0.0544	+0.6087	+0.3301

The x's pass through two complete cycles in fifty-six days, thus again showing the tendency of the observations to group themselves in periods of twenty-eight days.

The present investigation would appear to show, therefore, that, at the time of these observations, the measured differences between the equatorial and polar diameters of the sun had a decided tendency to fluctuate in a period of approximately twenty-eight days. This would indicate that the sun's equator was deformed; whether this deformation was permanent or transitory, the observations afford no means of deciding.

PART IV. CONCLUSIONS.

The general results of the present investigation may be summed up in the following: —

1. The exact shape of the sun is not known. The generally accepted idea that the sun is a sphere is at least open to question. Practically every series of measures heretofore made show departures from a spherical form; but these departures are extremely minute, the difference between the different radii of the sun being probably not more than 0″.25.

2. A study of all the available heliometer measures shows a fluctuation in the shape of the sun corresponding in period with the sun-spot cycle. The amplitude of this fluctuation is small, being probably not over 0″.10. This variation is shown by the great mass of heliometer measures made by the German observers in connection with the transits of Venus in 1874 and 1882, and by the superb series of observations made by Schur and Ambronn at Göttingen in 1890–1902.

3. In addition to this long-period variation, the observations of Schur and Ambronn would seem to indicate a fluctuation in the measured value of P.–E. having a period of about twenty-eight days. The observations are so scattered that they do not permit of a thorough determination of the reality of this fluctuation and of the exact length of its period. If real, this fluctuation can be accounted for by a permanent or semi-permanent deformation of the sun's equator.

4. Questions as to the exact shape of the sun, and as to possible variations in its size and shape, can only be set at rest by a long series of homogeneous observations. The data at present available are not sufficient for this purpose. Observations should be made on every clear day, and the series should be extended over at least one solar cycle.

5. A photographic heliometer would probably furnish the best results. With such an instrument, the moments of good "seeing" can be utilized and a number of plates taken within a short time. These plates can later be measured and reduced by the ordinary staff of a computing bureau.

COLUMBIA UNIVERSITY,
March, 1908.

No. 14. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THIRTY-FOUR STARS NEAR "BRADLEY 3077," BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences, Vol. X., pp. 161–187. August, 1897. *Octavo.*

No. 15. THE PRÆSEPE GROUP; MEASUREMENT AND REDUCTION OF THE RUTHERFURD PHOTOGRAPHS, BY FRANK SCHLESINGER. Annals of the New York Academy of Sciences, Vol. X., pp. 188–286. May, 1898. *Octavo.*

No. 16. THE POSITIONS AND PROPER MOTIONS OF THE PRINCIPAL STARS IN THE CLUSTER OF COMA BERENICES AS DEDUCED FROM MEASUREMENTS OF THE RUTHERFURD PHOTOGRAPHS, BY WALTER C. KRETZ. Annals of the New York Academy of Sciences, Vol. XII., pp. 342–478. February, 1900. *Octavo.*

No. 17. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THE GROUP OF THE PLEIADES (Second Paper), BY HAROLD JACOBY. pp. 24. January, 1901. *Octavo.*

No. 18. THE PARALLAX OF μ CASSIOPEIÆ AND THE POSITIONS OF 56 NEIGHBORING STARS AS DEDUCED FROM THE RUTHERFURD PHOTOGRAPHIC MEASURES, BY GEORGE N. BAUER. pp. 102. April, 1901. *Octavo.*

No. 19. CATALOGUE OF 287 STARS NEAR THE SOUTH POLE, AND OPTICAL DISTORTION OF THE CAPE OF GOOD HOPE ASTRO-PHOTOGRAPHIC TELESCOPE, BY HAROLD JACOBY. pp. 70. April, 1902. *Octavo.*

No. 20. THE SUMATRA ECLIPSE, 1901. SPECTROGRAPHIC STUDY OF THE FLASH SPECTRUM: NEW GASES IN THE SUN, BY S. A. MITCHELL. pp. 42. November, 1903. *Octavo.*

No. 21. PHOTOGRAPHIC CATALOGUE OF 829 STARS NEAR THE SOUTH POLE OF THE HEAVENS; AN EXAMPLE OF INTER-ADJUSTING OVERLAPPNG PLATES, BY HAROLD JACOBY. pp. 153. January, 1904. *Octavo.*

No. 22. RESEARCHES AS TO THE IDENTITY OF THE PERIODIC COMET OF 1889–1896–1903 (BROOKS) WITH THE PERIODIC COMET OF 1770 (LEXELL), BY CHARLES LANE POOR. pp. 82. December, 1904. *Octavo.*

No. 23. TABLES FOR THE REDUCTION OF ASTRONOMICAL PHOTOGRAPHS, BY HAROLD JACOBY. pp. 24. February, 1905. *Octavo.*

No. 24. RUTHERFURD PHOTOGRAPHS OF THE STELLAR CLUSTERS *h* AND X PERSEI, BY ANNE SEWELL YOUNG. pp. 76. September, 1906. *Octavo.*

No. 25. RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING 59 CYGNI, BY HAROLD JACOBY. pp. 23. January, 1908. *Octavo.*

No. 26. AN INVESTIGATION OF THE FIGURE OF THE SUN AND OF POSSIBLE VARIATIONS IN ITS SIZE AND SHAPE, BY CHARLES LANE POOR. Annals of the New York Academy of Sciences, Vol. XVIII, pp. 385–424. August, 1908. *Octavo.*

LIST OF
CONTRIBUTIONS FROM THE OBSERVATORY OF COLUMBIA UNIVERSITY, NEW YORK.

A List of Errata in the Contributions from the Observatory of Columbia University will be found in Contribution 19, p. 68 and 24, p. 74.

No. 1. Lewis Morris Rutherfurd, by John K. Rees. pp. 15. July, 1906. *Octavo*

No. 2. A Catalogue of Rutherfurd's Photographic Plates of the Sun, the Moon and the Stars, by John K. Rees. pp. 7. July, 1906. *Octavo.*

No. 3. The Rutherfurd Photographic Measures of the Group of the Pleiades, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. VI, pp. 239–330. February, 1892. *Octavo.*

No. 4. The Rutherfurd Photographic Measures of the Stars about β Cygni, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. VI., pp. 331–348. May, 1892. *Octavo.*

No. 5. The Parallaxes of μ and θ Cassiopeiæ Deduced from Rutherfurd Photographic Measures, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. VIII., pp. 1–23. March, 1893. *Octavo.*

No. 6. The Parallax of η Cassiopeiæ Deduced from the Rutherfurd Photographic Measures, by Herman S. Davis. Annals of the New York Academy of Sciences, Vol. VIII., pp. 301–321. April, 1895. *Octavo.*

No. 7. The Rutherfurd Photographic Measures of Sixty-Two Stars about η Cassiopeiæ, by Herman S. Davis. Annals of the New York Academy of Sciences, Vol. VIII., pp. 381–416. June, 1895. *Octavo.*

No. 8. Declinations and Proper Motions of Fifty-six Stars, by Herman S. Davis, Ph.D. Memoir I., Part 1, New York Academy of Sciences, pp. 105. June, 1895. *Quarto.*

No. 9. The Variation of Latitude at New York City from Observations, by John K. Rees, Harold Jacoby and Herman S. Davis. Memoir I., Part 2, New York Academy of Sciences, pp. 236. July, 1906. *Quarto.*

No. 10. On the Reduction of Stellar Photographs with Special Reference to the Astro-Photographic Catalogue Plates, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. IX., pp. 101–123. April, 1896. *Octavo.*

No. 11. On the Permanence of the Rutherfurd Photographic Plates, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. IX., pp. 195–284. October, 1896. *Octavo.*

No. 12. The Rutherfurd Photographic Measures of Sixty-five Stars near 61 Cygni, by Herman S. Davis. Annals of the New York Academy of Sciences. Vol. X., pp. 58–121. August, 1897. *Octavo.*

No. 13. The Parallaxes of 61^1 and 61^2 Cygni Deduced from the Rutherfurd Photographic Measures, by Herman S. Davis. Annals of the New York Academy of Sciences, Vol. X., pp. 123–160. August, 1897. *Octavo.*

UNIV. OF MICH.
DEC 18 1910

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—No. 27
HAROLD JACOBY, Director

RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING β CYGNI

BY

MORRIS FRANCIS WEINRICH

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY IN THE FACULTY OF
PURE SCIENCE, COLUMBIA UNIVERSITY

PUBLISHED FROM THE
RUTHERFURD STUYVESANT FUND
NEW YORK
1909

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—No. 27
HAROLD JACOBY, Director

RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING β CYGNI

BY

MORRIS FRANCIS WEINRICH

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY IN THE FACULTY OF
PURE SCIENCE, COLUMBIA UNIVERSITY

PUBLISHED FROM THE
RUTHERFURD STUYVESANT FUND
NEW YORK
1909

PRESS OF
THE NEW ERA PRINTING COMPANY
LANCASTER, PA

CONTENTS.

PAGE.
Introductory 5
Statement of Problem 6
Measurement of Plates 8
Reduction of Coördinates 9
Refraction 9
Precession, Nutation and Aberration 12
Plate Constants 12
Standard Coördinates of Series (B) 15
Intercomparison of Set (3) and Set (4) 19
Preliminary Catalog 22
Mean Rectangular Coördinates from Set (1) and Set (2) 23
Standard Coördinates of Series (A) 23
Intercomparison of Set (1) and Set (2) 26
Final Coördinates 26
Magnitudes 26
Final Catalog 30
Discussion of Results 31

RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING β CYGNI.

Introductory. — The present paper contains results derived from fourteen negatives made by Rutherfurd in the years 1875 and 1876. The plates obtained in 1875 were measured in the same year under Rutherfurd's direction and were reduced in 1892,[1] while those taken in 1876 were measured at Columbia University in the spring of 1899, and are here discussed for the first time.

All the plates under consideration were made with Rutherfurd's 13-inch objective and photographic corrector. As usual, three exposures were impressed on each plate, the first two having a duration of about six minutes and the last being just long enough to obtain a third image of β and β_2, the two brightest stars. In making these exposures the clockwork was alternately thrown in and out of action so that the distance on the plates between the first and second images is about 1.0 mm. in right ascension while the third images are about 37.5 mm. to the west of the first. The object of this third exposure was to afford means for determining the orientation correction of the plate. We have used the third image of the central star only for the adjustment of the plate in the measuring machine, the orientation correction being determined from known stars.

The telescope and plate holder were so adjusted by Rutherfurd that the double star β Cygni coincided approximately with the plate centre, defined as the point where the optical axis of the lenses normally pierces the plate.

Table I gives the data of exposure; excepting the "zenith distance" which was computed by the usual formulæ, all were inscribed upon the plate by Rutherfurd himself. The "sidereal time" is the mean of the four instants of beginning and ending of the two six-minute exposures. Of the three thermometers used, the first was attached to the mercurial barometer, the second was in the open air, and the third fastened to the telescope tube. The column "focus" contains readings of a micrometer on the plate end of the telescope indicating on an arbitrary scale the distance of the plate holder from the objective and intended by Rutherfurd to be used in the determination of the scale value. These readings were not used in the reductions as the scale value was separately determined for each plate from the position of known stars.

---

[1] The Rutherfurd photographic measures of the stars about β Cygni. By Harold Jacoby. *Annals N. Y. Acad. Sci.*, VI, May, 1892.

TABLE I.—PHOTOGRAPHS OF β CYGNI.

OBSERVATORY OF L. M. RUTHERFURD, NEW YORK.

Lat. $40^\circ\ 43'\ 48''.5$. Long. $4^h\ 55^m\ 56^s.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Zenith Dist.
				Att.	Ext.	Tel.		
		h m s	in.					°
1	1875 July 26	18 45 52	30.10	75°	74°	76°	7.6	15.40
2	1875 July 26	19 13 28	30.10	75	74	76	7.6	13.28
3	1875 July 26	19 38 42	30.10	75	74	76	7.6	13.32
4	1875 Sep. 20	20 27 22	29.95	57	55	60	7.7	18.18
5	1875 Sep. 20	21 53 52	29.95	57	55	60	7.9	32.98
6	1875 Sep. 20	22 20 12	29.95	57	55	60	7.7	37.90
7	1876 May 31	16 10 48	30.26	56	53	60	7.7	41.76
8	1876 May 31	17 0 38	30.26	56	53	60	7.7	32.40
9	1876 June 1	15 25 48	29.95	60	58	60	7.7	50.28
10	1876 June 1	15 53 38	29.95	60	58	60	7.7	45.00
12	1876 Oct. 24	22 38 2	29.69	59	55	60	7.7	41.30
13	1876 Oct. 24	23 9 32	29.69	59	55	60	7.7	47.26
14	1876 Nov. 4	21 45 18	30.29	52	50	55	7.75	31.40
15	1876 Nov. 4	22 33 2	30.29	52	50	55	7.75	40.30

A plate of the series marked No. 11 has never been found among the Rutherfurd photographs now owned by Columbia University and was perhaps an unsuccessful exposure made on October 24, 1876.

Statement of Problem. — The fourteen plates above listed naturally fall into two "Series" and four "Sets" in the following manner:

Series (A).		Series (B)	
Set (1).	Set (2).	Set (3).	Set (4).
Plate.	Plate.	Plate.	Plate.
1	4	7	12
2	5	8	13
3	6	9	14
		10	15

As aforesaid the plates of Sets (1) and (2) were completely reduced[1] in 1892. In the course of reduction a curious displacement of β Cygni was noted when the corrected Mean Distances and Position angles of Sets (1) and (2) were compared. Jacoby considered the displacement, which varied with position angle only, as possibly parallactic and deduced a value of $+ 0''.97$[2] for the parallax. Later after introducing data obtained from plates of Sets (3) and (4) a smaller value amounting to about $+ 0''.61$[3] was found. Hereupon Chase[4] made a heliometer search for parallax of this star and found a value of $- 0''.018 \pm 0''.016$. This heliometric result seemed to indicate with certainty that the photographic displacement was not due to parallax, and thereby left the real cause undetermined.

It was therefore decided to so plan the work as to obtain four separate positions of β Cygni corresponding to the mean epochs of Sets (1), (2), (3) and (4). It was hoped that from these results positive conclusions could be drawn. This formed one part of the problem. The other part was the determination of the positions of 43 stars about β Cygni. This part of the work was divided into four steps as follows:

First: An intercomparison of the separate plates of Sets (3) and (4).

Second: A reduction of two sets of mean results derived from Sets (3) and (4), using the *Astronomische Gesellschaft* Catalog as standard.

Third: A reduction of two sets of mean results derived from the mean coördinates of Sets (1) and (2) using the mean of the two positions of the stars as obtained in step two as standard.

---

[1] *Annals N. Y. Acad. Sci.*, VI, May, 1892.

[2] *A. J.*, Vol. XII, No. 287, p. 182.

[3] *A. J.*, Vol. XIII, No. 293, p. 37.

[4] *A. J.*, Vol. XIII, No. 307, p. 162.

Fourth: A reduction of final position from the mean results of steps two and three and a calculation of the precession constants and the magnitudes.

Measurement of Plates. — The plates of Series (B) were measured in the spring of 1899 by Miss F. E. Harpham, assisted by Miss Tarbox, in the usual Repsold machine. This machine corresponds very closely to the description given by Scheiner[1] of a similar instrument in use at the Leyden Observatory, differing only in that an alteration has been made which obviates "projection errors." This alteration consists of a contrivance by means of which it is possible to rotate the slide of the microscope through a small angle with great accuracy and without jar, so that the same micrometer is used for bisecting the star and setting on the scale.

The reading microscope is provided with both horizontal and vertical screws but in these measures only the horizontal screw was used. The screw has a pitch of one half millimeter, two revolutions corresponding to one millimeter scale division. The micrometer head is divided into one hundred parts, so that by estimating tenths of a division the scale may be read to half-microns (0.0005 mm.) which corresponds to about $0''.026$ on the Rutherford plates.

Each plate was measured in four positions, designated as "x direct," "y direct," "x reversed" and "y reversed." Both images of each star were observed in the order: first image direct, second image direct, first image reversed, second image reversed, in the x and y direction, giving four separate x and y readings each of which was itself determined from four separate and distinct settings on both the star and the scale.

Instrumental corrections were applied to these measures as follows:

1. Screw errors of the microscope.
2. Corrections for runs.
3. Division errors of the measuring machine scale.
4. "Rotation corrections" to render the two coördinates perfectly rectangular.

---

[1] Die Photographie der Gestirne, p. 148.

After the corrections had been applied to the four separate x readings they were reduced to the center by comparing the first and second with the direct and the third and fourth with the reversed reading for the central star, the average of these four results now giving the x-coördinate of the star fully corrected for all instrumental errors as given in Table II. The y-coördinates given in the table were obtained in an exactly similar manner.

Reduction of Coördinates.— The first step in the reduction of the coördinates given in Table II is to change them from millimeters to seconds of arc approximately, using a scale value 1 mm. = 52''.87 which is an average for Rutherfurd plates. A small correction to this scale value will be determined as one of the constants for each plate.

Refraction.— Refraction affects both position angles and distances of stars upon the photographic plate. Of the various formulæ which have been developed for the determination of its effect upon the x- and y-coördinates we have used those of Jacoby[1] first deduced by him from formulas published by Rambaut.[2]

Let:

φ = the latitude of Rutherfurd's Observatory.

θ = the sidereal time of exposure as given in Table I.

α and δ = the right ascension and declination of the plate-centre approximately.

β = the usual refraction constants increased by 1/65 to allow for the difference between photographic and visual refractions.

If we then compute the auxiliary quantities :

$$\begin{aligned}
\tan N &= \cot \phi \cos (\theta - \alpha).\\
G &= \cot (\delta + N),\\
H &= \tan (\theta - \alpha) \sin N \operatorname{cosec} (\delta + N),\\
M_x &= \beta(1 + H^2) \sin 1'',\\
N_x &= \beta(GH - H \tan \delta) \sin 1'',\\
M_y &= \beta(GH + H \tan \delta) \sin 1'',\\
N_y &= \beta(1 + G^2) \sin 1''.
\end{aligned}$$

---

[1] *A. J.*, Vol. XVII, No. 387, p. 22.

[2] *A. N.*, Band 131, No. 3125, p. 65.

TABLE II. — COÖRDINATES CORRECTED FOR INSTRUMENTAL ERRORS.

Star.	PLATE 7.		PLATE 8.		PLATE 9.		PLATE 10.	
	X	*Y*	*X*	*Y*	*X*	*Y*	*X*	*Y*
2			—55.4254	+ 0.0821			—55.4140	+ 0.0748
3	—43.5142	+31.2929	—43.5139	+31.3079	—43.4983	+31.3008	—34.5099	+31.3105
5			—38.9484	+54.3317	—38.9267	+54.3283		
6	—37.8604	— 2.3985	—37.8647	— 2.3883	—37.8550	— 2.3899	—37.8586	— 2.3932
8	—34.1682	—40.3442	—34.1700	—40.3340	—34.1819	—40.3318	—34.1689	—40.3405
9	—32.2997	+35.9055	—32.2979	+35.9174	—32.2782	+35.9088	—32.2900	+ 35.9114
11	—24.8720	— 2.0837	—24.8756	— 2.0776	—24.8667	— 2.0787	—24.8697	— 2.0842
12	—21.2346	—24.5238	—21.2338	—24.5174	—21.2313	—24.5180	—21.2365	—24.5200
13	—20.7890	+ 7.2121	—20.7867	+ 7.2185	—20.7795	+ 7.2194	—20.7804	— 7.2186
14	—15.7834	—40.6728	—15.7894	—40.6630	—15.8010	—40.6640	—15.7908	—40.6652
15	—11.7102	+51.8598	—11.7108	+51.8703	—11.6861	+51.8580	—11.7046	+51.8732
16	— 3.8466	—49.2306	— 3.8491	—49.2314	— 3.8612	—49.2262	— 3.8580	—49.2312
17	— 2.6454	+21.5084	— 2.6438	+21.5118	— 2.6311	+21.5077	— 2.6417	+21.5093
18	— 1.9040	+25.4793	— 1.8992	+25.4825	— 1.8845	+25.4803	— 1.8994	+25.4822
19	— 0.5292	— 0.3746	— 0.5336	— 0.3745	— 0.5278	— 0.3722	— 0.5303	— 0.3762
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	+ 1.3889	—25.2724	+ 1.3888	—25.2680	+ 1.3832	—25.2714	+ 1.3908	—25.2711
22	+ 1.6803	+39.1310	+ 1.6806	+39.1342	+ 1.6892	+39.1273	+ 1.6872	+39.1337
23	+ 5.7187	—42.8041	+ 5.7162	—42.8029	+ 5.7078	—42.8027	+ 5.7097	—42.8048
24	+ 6.5700	— 1.0076	+ 6.5732	— 1.0066			+ 6.5852	— 1.0022
25	+ 7.7538	+34.8777	+ 7.7600	+34.8805	+ 7.7792	+34.8763	+ 7.7736	+34.8813
26	+11.6805	+50.9916	+11.6854	+50.9958	+11.7022	+50.9892	+11.6928	+50.9936
27	+20.3438	+20.2870	+20.3459	+20.2868	+20.3496	+20.2809	+20.3472	+20.2850
28	+20.3451	+20.3948	+20.3519	+20.3911	+20.3580	+20.3846	+20.3566	+20.3900
30	+24.6524	— 3.1916	+24.6511	— 3.1953	+24.6477	— 3.1982	+24.6537	— 3.1940
31	+25.9586	—37.1298	+25.9612	—37.1300	+25.9430	—37.1356	+25.9573	—37.1256
32	+35.2589	—22.1788	+35.2567	—22.1810			+35.2541	—22.1816
35	+36.3166	—39.6183	+36.3158	—39.6168	+36.3018	—39.6268	+36.3106	—39.6218
36	+36.3274	+37.6380	+36.3320	+37.6342	+36.3396	+37.6319	+36.3376	+37.6343
37	+37.7769	—28.9343	+37.7781	—28.9364			+37.7688	—28.9350
38	+38.2992	—15.7404	+38.3049	—15.7481	+38.2915	—15.7526	+38.2979	—15.7465
39	+41.9841	+34.8416	+41.9993	+34.8349			+42.0071	+34.8400
39½	+43.3686	+26.4112	+43.3723	+26.4030			+43.3619	+26.4028
40	+47.8880	+21.4435	+47.8967	+21.4363			+47.8925	+21.4398
41	+50.4083	+14.3176	+50.4248	+14.3079			+50.4226	+14.3175
41½	+51.5831	+45.2704	+51.5905	+45.2768	+51.5933	+45.2702		
42	+51.7632	+30.1683	+51.7684	+30.1617	+51.7760	+30.1579	+51.7694	+30.1668

TABLE II.—COÖRDINATES CORRECTED FOR INSTRUMENTAL ERRORS.—*Concluded.*

Star.	Plate 12.		Plate 13.		Plate 14.		Plate 15.	
	X	*Y*	*X*	*Y*	*X*	*Y*	*X*	*Y*
2			−55.4005	+ 0.0526	−55.4162	+ 0.0523	−55.4112	+ 0.0572
3	−43.5252	+31.3016	−43.5316	+31.2859	−43.5364	+31.2919	−43.5264	+31.2854
5							−38.9732	+54.3287
6	−37.8464	− 2.3886	−37.8363	− 2.4070	−37.8561	− 2.4069	−37.8478	− 2.4011
8	−34.1390	−40.3443	−34.1267	−40.3437	−34.1317	−40.3519	−34.1329	−40.3476
9	−32.2948	+35.9230	−32.3150	+35.9084	−32.3180	+35.9071	−32.3139	+35.9076
11	−24.8556	− 2.0755	−24.8600	− 2.0835	−24.8662	− 2.0864	−24.8584	− 2.0832
12	−21.2110	−24.5216	−21.2020	−24.5274	−21.2112	−24.5300	−21.2021	−24.5204
13					−20.7869	+ 7.2090	−20.7823	+ 7.2118
14	−15.7560	−40.6654	−15.7398	−40.6644	−15.7529	−40.6757	−15.7446	−40.6697
15	−11.7214	+51.8875	−11.7533	+51.8663			−11.7426	+51.8822
16	− 3.8190	−49.2224	− 3.7975	−49.2302	− 3.8038	−49.2294	− 3.8036	−49.2294
17	− 2.6396	+21.5182	− 2.6466	+21.5102	− 2.6532	+21.5167	− 2.6472	+21.5192
18	− 1.8981	+25.4899	− 1.8994	+25.4914	− 1.9102	+25.4891	− 1.9155	+25.4938
19	− 0.5363	− 0.3736	− 0.5357	− 0.3731	− 0.5451	− 0.3714	− 0.5438	− 0.3692
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21					+ 1.4157	−25.2628		
22			+ 1.6462	+39.1330	+ 1.6588	+39.1459	+ 1.6575	+39.1472
23	+ 5.7538	−42.8028	+ 5.7622	−42.7933	+ 5.7604	−42.7973	+ 5.7601	−42.7969
24					+ 6.5955	− 0.9886		
25	+ 7.7698	+34.8877	+ 7.7482	+34.8801	+ 7.7444	+34.8944	+ 7.7446	+34.8952
26	+11.6764	+51.0075	+11.6526	+51.0046	+11.6548	+51.0169	+11.6592	+51.0135
27	+20.3544	+20.2944	+20.3376	+20.2958	+20.3421	+20.3052	+20.3445	+20.3018
28								
30	+24.6758	− 3.1816	+24.6663	− 3.1781	+24.6659	− 3.1754	+24.6661	− 3.1769
31	+25.9831	−37.1230	+25.9950	−37.1134	+25.9985	−37.1019	+25.9958	−37.1094
32								
35	+36.3458	−39.6200	+36.3622	−39.6046	+36.3620	−39.5969	+36.3616	−39.6068
36	+36.3340	+37.6473			+36.3200	+37.6653	+36.3230	+37.6648
37	+37.8067	−28.9376			+37.8156	−28.9147	+37.8190	−28.9225
38	+38.3270	−15.7388	+38.3278	−15.7303	+38.3287	−15.7203	+38.3341	−15.7250
39								
39½								
40								
41								
41½								
42	+51.7734	+30.1804	+51.7510	+30.1889	+51.7671	+30.2057	+51.7640	+30.2000

we can form the equations :

$$X = X' + M_x X' + N_x Y'$$
$$Y = Y' + M_y X' + N_y Y'.$$

in which X' and Y' denote the coördinates as given in Table II, and X and Y the same coördinate corrected for refraction.

The refraction coefficients obtained by the above formulæ for the plates of Series (B) are given in the subjoined table.

TABLE III.—REFRACTION COEFFICIENTS.

Plate.	M_x	N_x	M_y	N_y
7	+0.000455	+0.000014	−0.000217	+0.000349
8	+ .000368	+ .000027	− .000133	+ .000322
9	+ .000578	− .000030	− .000333	+ .009392
10	+ .000488	+ .000002	− .000251	+ .000357
12	+ .000439	− .000015	+ .000207	+ .000339
13	+ .000521	+ .000009	+ .000282	+ .000369
14	+ .000364	− .000027	+ .000127	+ .000323
15	+ .000442	− .000017	+ .000203	+ .000346

Twenty-one stars which occurred on all the plates of Series (B), and termed "Standard Stars" were by means of these constants corrected for refraction and their X- and Y-coördinates found.

Precession, Nutation and Aberration.—Precession and nutation merely rotate the axes of reference, not affecting in any way the position of the stars relative to each other. The effect of aberration is to alter the distance between the stars by a constant factor and to change the position angles equally in all directions. No corrections were therefore applied for precession, nutation and aberration as the rotation effects can be taken care of by the orientation constant and the alteration of the distances by the correction to the scale value.

Plate Constants.—The next step was an intercomparison of the plates in Set (3) and (4) taken separately. For this purpose the X- and Y-coördinates of the twenty-one "Standard Stars" were combined into arithmetical means designated by x_3, y_3, and x_4, y_4. In order to avoid confusion in carrying the two sets along together, let us devote our attention to Set (3). For this we now have twenty-one pairs of mean coördinates belonging to an imaginary mean plate. We now wish to obtain plate constants for each plate which will bring about the best possible agreement of that plate with the imaginary mean plate. These constants are obtained for the purpose of reducing the non-standard stars to the imaginary mean plate. For this purpose, we let:

p = a correction required by the assumed scale value.
r = a small angle through which the coördinate axes of the plate must be rotated, called the orientation correction.
k, c = corrections of the plate-center in x and y.

Then there results for each of the twenty-one stars a pair of equations of the form

$$pX + rY + k = x_s - X$$
$$pY - rX + c = y_s - Y$$

where the right-hand members are the coördinate differences between the mean plate and each individual plate of the set, taken in the sense mean *minus* plate.

These equations would be rigorously true and the four plate constants could be determined from any pair of known stars if it were not for the unavoidable accidental errors of measurement. On account of these errors it is of great advantage to have as many equations as possible and to solve for the plate constants by the method of least squares.

Owing to the peculiar arrangement of the unknowns in these equations we do not need to make the least square solution in the usual manner but may use the following auxiliary quantities as pointed out by Jacoby.[1] In these let ν be the number of comparison stars, and let us denote by square brackets the sum of ν quantities.

Put:

$$A = [XX] - \frac{[X]^2}{\nu},$$

$$C = [X(X-x)] - \frac{[X][X-x]}{\nu},$$

---

[1] H. Jacoby. Note on the Solution by Least Squares of the Equations arising in the Reduction of Photographic Star-plates. *Mo. Not. R.A.S.*, May, 1896, p. 424.

$$D = [YY] - \frac{[Y]^2}{\nu},$$

$$E = [Y(X-x)] - \frac{[Y][X-x]}{\nu},$$

$$C' = [Y(Y-y)] - \frac{[Y][Y-y]}{\nu},$$

$$E' = -[X(Y-y)] + \frac{[X][Y-y]}{\nu}.$$

Then :

$$p = -\frac{C+C'}{A+D}, \quad \text{weight of } p = A + D,$$

$$r = -\frac{E+E'}{A+D}, \quad \text{weight of } r = A + D,$$

$$k = -\frac{1}{\nu}\{[X]p + [Y]r + [X-x]\}, \quad \text{weight of } k = \nu - \frac{[X]^2+[Y]^2}{[XX]+[YY]},$$

$$c = -\frac{1}{\nu}\{[Y]p - [X]r + [Y-y]\}, \quad \text{weight of } c = \nu - \frac{[X]^2+[Y]^2}{[XX]+[YY]}.$$

If $[vv]$ represents the sum of the squares of the residuals of the ν right ascension equations plus the ν declination equations the probable error of a single equation will will be

$$\pm 0.6745\sqrt{\frac{[vv]}{2\nu-4}}$$

and the probable error of one of the unknowns will be this quantity divided by the square root of the weight of the unknown, as given above.

A very convenient check on the computations is given by the fact that the sum of the residuals of the right ascension, as well as of the declination equations must be approximately equal to zero.

Using the above method in solving the forty-two equations for each plate of Set (3) we obtain values for *p, r, k* and *c*, suitable for the reduction of each individual plate to the mean plate, these together with the values obtained for Set (4), are contained in the following table.

TABLE IV.—PLATE CONSTANTS.

Plate.	*p*	*r*	Probable Error of *p* or *r*.	*k*	*c*	Probable Error of *k* or *c*.	Probable Error of One Equation.
7	+0.000004	+0.000130	±0.000012	+0.″027	+0.″071	±0.″026	±0.″1207
8	+ .000024	+ .000066	.000006	+ .046	— .100	.014	.0621
9	— .000008	— .000207	.000009	— .102	+ .056	.019	.0880
10	— .000027	— .000017	.000009	— .018	— .030	.019	.0852
12	— .000016	— .000270	.000011	— .137	+ .022	.022	.1027
13	+ .000045	+ .000098	.000011	— .030	+ .109	.024	.1109
14	— .000017	+ .000101	.000009	+ .154	— .072	.020	.0898
15	— .000013	+ .000072	.000010	+ .014	— .061	.021	.0962

The coördinates of the non-standard stars as given in Table II after having been reduced to seconds of arc were now corrected as follows:

for X'', $(p + M_x)X'' + (r + N_x)Y'' + k$,
for Y'', $(-r + M_y)X'' + (p + N_y)Y'' + c$.

The means of the corrected coördinates of the non-standard stars were now taken separately for the two sets, and these, together with the means of the standard stars corrected for refraction, gave us mean coördinates of all stars for each set. It was, of course, not necessary to apply the corrections, as given in the last two equations, to the standard-stars as these have already been corrected for refraction, and the correction

for X'', $pX'' + rY'' + k$,
for Y'', $pY'' - rX'' + c$,

would not have appreciably altered the mean coördinates already formed on account of the method by which *p*, *r*, *k* and *c* were obtained.

Having thus reduced all coördinates to two mean systems, Tables V and VI were formed. These tables give the arithmetrical averages of all coördinates reduced as above, together with the differences between each plate and the average, taken in the sense plate *minus* average.

Standard Coördinates of Series (B). — The mean coördinates of Tables V and VI were next corrected in such a way as to

TABLE V.—MEAN X'S AND Y'S AND RESIDUALS FOR EACH PLATE OF SET (3).

Star.	x_3	7	8	9	10	y_3	7	8	9	10
	″	″	″	″	″	″	″	″	″	″
2	—2931.28		—.16		+.17	+ 4.72		+.10		—.10
3	—2301.41	+.02	+.12	—.16	—.07	+1656.12	—.20	+.06	—.26	+.33
5	—2059.84		+.15	—.16		+2873.79		—.03	+.03	
6	—2002.59	.00	—.07	—.02	+.07	— 126.07	—.02	+.06	—.02	—.07
8	—1807.54	—.04	+.11	—.29	+.22	—2132.99	—.06	+.05	+.11	—.12
9	—1708.05	—.12	+.01	—.03	+.04	+1899.68	—.03	+.17	—.18	—.04
11	—1315.55	—.02	—.09	+.02	+.07	— 109.76	+.08	+.03	+.04	—.19
12	— 1123.18	—.17	+.04	+.25	—.11	—1296.56	—.01	.00	—.02	.00
13	—1099.37	—.16	+.04	—.06	+.17	+ 381.96	—.08	—.07	+.08	+.05
14	— 835.28	+.14	.00	—.19	+.05	—2150.59	—.18	+.06	+.02	+.07
15	— 619.04	+.06	—.04	+.10	—.13	+2743.23	—.15	+.12	—.31	+.33
16	— 203.85	+.04	+.08	+.11	—.20	—2603.66	+.06	—.16	+.16	—.03
17	— 139.66	—.06	—.02	+.10	—.12	+1137.64	+.03	+.02	—.01	—.05
18	— 100.32	—.17	+.04	+.21	—.19	+1347.68	—.01	—.04	+.04	.00
19	— 28.04	+.07	—.14	+.02	—.03	— 19.80	+.06	—.11	+.17	—.12
20	0.00	+.03	+.05	—.10	—.02	0.00	+.07	—.10	+.06	—.03
21	+ 73.41	—.11	—.02	—.02	+.15	—1336.55	—.03	+.06	—.01	—.02
22	+ 89.07	+.14	+.05	—.30	+.12	+2069.60	+.03	+.03	—.10	+.03
23	+ 302.19	.00	—.02	+.18	—.16	—2263.90	+.01	—.03	+.07	—.04
24	+ 347.85	—.31	—.13		+.45	— 53.29	—.05	—.12		+.17
25	+ 410.82	—.39	—.17	+.16	+.31	+1844.60	—.04	—.01	+.02	+.06
26	+ 618.37	+.88	—.02	—.06	+.06	+2696.79	—.05	+.07	+.02	—.05
27	+1076.24	+.02	+.02	—.10	—.03	+1072.59	+.05	+.03	—.01	—.05
28	+1076.55	—.22	+.02	+.03	+.16	+1078.16	+.19	—.02	—.10	—.06
30	+1303.92	+.05	—.07	—.13	+.11	— 169.27	+.09	—.08	+.01	+.01
31	+1372.88	—.08	+.10	—.13	+.13	—1964.09	—.06	—.02	—.14	+.27
32	+1864.76	+.10	—.07		—.02	—1173.59	+.01	.00		—.01
35	+1920.68	—.02	—.06	+.09	—.03	—2095.95	—.01	+.20	—.11	—.02
36	+1921.88	—.05	—.02	—.08	+.13	+1990.01	+.01	—.08	+.17	—.10
37	+1997.92	+.07	+.10		—.16	—1530.87	—.05	—.03		+.08
38	+2025.79	—.07	+.16	—.08	—.05	— 833.31	+.19	—.08	—.05	+.01
39	+2221.50	—.48	+.09		+.39	+1841.97	+.06	—.15		+.08
39½	+2293.97	+.21	+.20		—.41	+1395.93	+.19	—.08		—.12
40	+2533.28	—.09	+.17		—.07	+1133.24	+.07	—.11		+.03
41	+2666.87	—.42	+.25		+.17	+ 756.35	+.04	—.26		+.22
41½	+2728.79	+.03	+.14	—.17		+2393.82	—.41	+.15	+.26	
42	+2738.34	—.11	—.07	+.14	—.07	+1594.68	+.01	—.12	+.10	+.10

TABLE VI.—MEAN *X*'S AND *Y*'S AND RESIDUALS FOR EACH PLATE OF SET (4).

Star.	x_4	12	13	14	15	y_4	12	13	14	15
	″	″	″	″	″	″	″	″	″	″
2	−2930.76		+.05	+.04	−.08	+ 2.52		−.17	+.10	+.06
3	−2302.46	−.30	−.22	+.17	+.33	+1654.46	−.09	.00	+.31	−.22
5	−2061.22				.00	+2872.99				.00
6	−2001.84	−.05	+.26	−.17	−.02	− 127.39	+.13	−.18	−.02	+.08
8	−1805.36	+.14	−.20	+.19	−.13	−2134.24	−.28	+.16	+.07	+.05
9	−1709.03	+.20	−.25	+.08	−.03	+1898.94	+.13	+.12	−.07	−.16
11	−1314.93	+.14	−.20	−.06	+.11	− 110.39	+.02	+.06	−.07	−.02
12	−1121.67	.00	−.08	−.10	+.16	−1297.30	−.09	−.10	−.10	+.27
13	−1099.20			.00	.00	+ 381.19			−.03	+.03
14	− 832.96	+.06	+.07	−.19	+.08	−2151.07	+.02	+.21	−.20	−.02
15	− 621.11	+.22	−.38		+.17	+2743.66	+.24	−.35		+.12
16	− 201.28	−.11	+.10	+.06	−.04	−2603.62	+.32	−.19	−.02	−.09
17	− 140.00	−.08	+.09	−.08	+.06	+1137.92	+.08	−.13	−.06	+.10
18	− 100.82	−.09	+.46	+.04	−.40	+1348.16	−.10	+.22	−.20	+.08
19	− 28.57	+.08	+.21	−.11	−.18	− 19.68	−.08	+.04	−.04	+.08
20	0.00	−.14	−.03	+.15	+.01	0.00	+.02	+.11	−.07	−.06
21	+ 74.93			.00		−1336.12			.00	
22	+ 87.70		−.43	+.33	+.09	+2070.17		−.22	+.03	+.18
23	+ 304.64	+.19	−.09	.00	−.08	−2263.42	−.13	+.18	−.02	−.02
24	+ 348.97			.00		− 52.35			.00	
25	+ 410.00	+.30	+.05	−.12	−.25	+1845.32	+.01	−.26	+.06	+.20
26	+ 616.74	−.06	−.07	+.02	+.10	+2697.98	−.02	−.03	+.05	+.02
27	+1076.08	+.07	−.14	+.01	+.07	+1073.82	+.02	−.03	+.01	−.02
28										
30	+1304.80	+.27	.00	−.12	−.13	− 167.81	+.19	+.06	−.15	−.10
31	+1374.89	−.16	+.01	+.13	.00	−1962.50	−.16	−.13	+.28	.00
32										
35	+1923.12	−.25	+.18	+.01	+.05	−2094.36	−.09	+.06	+.20	−.15
36	+1921.21	−.13		.00	+.13	+1992.04	−.05		−.09	+.15
37	+2000.10	−.11		−.06	+.18	−1529.37	−.08		+.16	−.07
38	+2027.38	−.08	+.04	−.14	+.18	− 831.44	+.05	−.09	+.04	−.02
39										
39½										
40										
41										
41½										
42	+2737.95	−.12	−.18	+.21	+.08	+1597.46	+.03	−.10	+.02	+.04

bring about the best possible agreement with the star places in the *Astronomische Gesellschaft* Catalog. Table VII shows which stars of Series (B) appear in the *Astronomische Gesellschaft* Catalog.

TABLE VII.—CONCORDANCE WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Photo. No. of Star.	No. in A. G. Catalog.	Photo. No. of Star.	No. in A. G. Catalog.	Photo. No. of Star.	No. in A. G. Catalog.	Photo. No. of Star.	No. in A. G. Catalog.
2	9989	14	10036	23	10056	36	10090
3	10006	15	10039	24	10059	37	10093
5	10009	16	10047	25	10061	38	10094
6	10010	17	10048	26	10066	39½	10098
8	10019	19	10049	27	10074	40	10104
9	10020	20	10052	30	10079	41½	10110
11	10026	21	10053	31	10081	42	10111
12	10032	22	10054	35	10089		

NOTE.—No. 19 is β Cygni and No. 20 is β_2 Cygni.

The method used to procure this agreement was that published by Jacoby.[1] In this method, rectangular coördinates x_c and y_c are computed from the *Astronomische Gesellschaft* Catalog places, and then a series of equations similar to that used before are solved. These equations are:

For Set (3)

$$px_3 + ry_3 + k + (x_3 - x_c) = 0,$$

$$py_3 - rx_3 + c + (y_3 - y_c) = 0,$$

those for Set (4) having the mean values of the coördinates for that set substituted for x_3 and y_3. The rectangular coördinates computed from the *Astronomische Gesellschaft* Catalog are here designated by x_c and y_c. These were computed by the following formulæ as given in the paper just mentioned. Terms of the fourth order were inappreciable.

$$\begin{aligned} x_c = x' &+ J_1'x'y', & J_1' &= -\tan\delta \sin 1'', \\ &+ J_2'x'^3, & J_2' &= \tfrac{1}{3}\left(1 - \tfrac{1}{2}\tan^2\delta\right)\sin^2 1'', \\ &+ J_3'x'^3y', & J_3' &= \left(-\tfrac{5}{6}\tan\delta + \tfrac{1}{6}\tan^3\delta\right)\sin^3 1'', \\ &+ J_4'x'y'^3, & J_4' &= -\tfrac{1}{3}\tan\delta\sin^3 1'', \end{aligned}$$

---

[1] Tables for the Reduction of Astronomical Photographs. *Contrib. Col. Univ. Observatory*, 23.

$$\begin{aligned} y_c = y' &+ K_1'x'^2, & K_1' &= \tfrac{1}{2}\tan\delta \sin 1'', \\ &+ K_2'x'^2y', & K_2' &= \tfrac{1}{2}(1 - \tan^2\delta)\sin^2 1'', \\ &+ K_3'y'^3, & K_3' &= \tfrac{1}{2}\sin^2 1'', \\ &+ K_4'x'^2y'^2 & K_4' &= -\tfrac{1}{2}\tan\delta \sin^3 1'', \\ &+ K_5'x'^4, & K_5' &= (\tfrac{5}{24}\tan\delta - \tfrac{1}{24}\tan^3\delta)\sin^3 1''. \end{aligned}$$

The quantities herein indicated by x' and y' have the following value:

$$x' = (\alpha' - \alpha)\cos\delta, \quad y' = \delta' - \delta$$

where α and δ are the right-ascension and declination of the central star and α' and δ' are the right-ascension and declination of the star in question. The differences $(\alpha' - \alpha)$ and $(\delta' - \delta)$ are expressed in seconds of arc, so that x' and y' and consequently x_c and y_c are also in seconds of arc. In these computations no attention was paid to proper motion, the epochs of the plates and the *Astronomische Gesellschaft* Catalog being nearly the same.

A solution of the sixty equations due to Set (3) and of the fifty due to Set (4) gave the plate constants and residuals contained in Table VIII. The probable errors of one equation, and the residuals are much larger than in the foregoing solutions due to the fact that they now include the rather large errors of the meridian circle places.

With the values of p, r, k and c of Table VIII the mean coördinates given in Tables V and VI were next corrected, giving the standard coördinates for Sets (3) and (4) designated by X_3, Y_3 and X_4, Y_4 in Table IX. For stars appearing in both sets these coördinates were now averaged after weights were given to the coördinates according to the following rule: Stars appearing on all four plates of either set are given a weight of one for that set, stars appearing on two or three plates of a set are given a weight of three fourths for that set, and if appearing on only one of the four plates are given a weight of one half.

Intercomparison of Sets (3) and (4).— The coördinates of the stars for which it was possible to obtain an average were now taken to be the Final Coördinates for Series (B) designated by X_B and Y_B, and the standard coördinates of Set (3) were com-

TABLE VIII. — COMPARISON OF SET (3) AND SET (4) WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Set (3).			Set (4).		
$p = +\ 0.000448 \pm 0.000044$ $r = -\ 0.000584 \pm 0.000044$ $k = +\ 2''.487 \pm 0''.102$ $c = +\ 0''.105 \pm 0''.102$ Prob. error of one equ. = ± 0″.5536			$p = +\ 0.000311 \pm 0.000046$ $r = +\ 0.000194 \pm 0.000046$ $k = +\ 1''.814 \pm 0''.103$ $c = -\ 0''.219 \pm 0''.103$ Prob. error of one equ. = ± 0.″5159		
Star.	v_x	v_y	Star.	v_x	v_y
	″	″		″	″
2	−1.67	+1.39	2	−1.42	+1.15
3	−0.67	−0.47	3	−0.79	−0.90
6	+1.18	+0.42	6	+1.43	+0.35
8	−0.10	−0.16	8	+0.01	−0.04
9	−0.65	+0.59	9	−0.58	+0.60
11	+1.97	+0.12	11	+2.01	+0.21
12	+0.42	−0.65	12	+0.39	−0.67
14	−1.07	−0.02	14	−0.98	+0.12
15	+0.07	−0.57	15	−0.45	−0.35
16	−0.20	+0.35	16	−0.30	+0.59
17	−0.06	+0.43	17	−0.17	+0.34
19	+1.80	−0.32	19	+0.59	−0.50
20	+2.49	+0.10	20	+1.81	−0.22
21	+0.35	−0.39	21		
22	−0.63	−0.60	22	−1.08	−0.70
23	−0.81	−0.46	23	−0.83	−0.23
24	−1.59	−0.16	24		
25	+0.15	+0.31	25	+0.02	+0.12
26	−0.47	−0.29	26	−0.76	−0.27
27	+1.17	−0.10	27	+1.02	−0.19
30	+0.25	+0.15	30	+0.14	+0.30
31	−0.95	−1.17	31	−1.33	−0.70
35	+0.72	+0.10	35	+0.60	+0.18
36	+0.56	−0.35	36	+0.51	−0.41
37	−0.50	+0.33	37	−0.46	+0.17
38	+0.83	+0.43	38	+0.82	+0.51
39½	−0.48	+0.55	39½		
40	−1.36	+0.41	40		
41½	−0.73	−0.39	41½		
42	0.00	+0.43	42	−0.20	+0.53

TABLE IX. — FINAL COÖRDINATES OF SERIES (*B*).

Star.	X_3	X_4	X_B	Y_3	Y_4	Y_B
2	−2930.10	−2929.86	−2929.98	+ 3.11	+ 2.87	+ 2.99
3	−2300.92	−2301.05	−2300.98	+1655.62	+1655.20	+1655.41
5	−2059.95	−2059.49	−2059.77	+2873.98	+2774.06	+2874.01
6	−2000.92	−2000.67	−2000.80	− 127.20	− 127.26	− 127.23
8	−1804.62	−1804.52	−1804.57	−2134.90	−2134.77	−2134.84
9	−1707.44	−1707.38	−1707.41	+1899.63	+1899.64	+1899.64
11	−1313.59	−1313.55	−1313.57	− 110.48	− 110.39	− 110.44
12	−1120.43	−1120.46	−1120.44	−1297.69	−1297.70	−1297.70
13	−1097.59	−1097.66	−1097.62	+ 381.59	+ 381.30	+ 381.47
14	− 831.91	− 831.83	− 831.87	−2151.94	−2151.80	−2151.87
15	− 618.43	− 618.96	− 618.66	+2744.20	+2744.41	+2744.29
16	− 199.93	− 200.03	− 199.98	−2604.84	−2604.61	−2604.72
17	− 137.90	− 138.01	− 137.96	+1138.17	+1138.08	+1138.12
18	− 98.66	− 98.78	− 98.72	+1348.32	+1348.38	+1348.35
19	− 25.55	− 26.77	− 26.16	− 19.73	− 19.90	− 19.82
20	+ 2.49	+ 1.81	+ 2.15	+ 0.10	− 0.22	− 0.06
21	+ 76.71	+ 76.50	+ 76.64	−1337.01	−1336.77	−1336.93
22	+ 90.39	+ 89.94	+ 90.20	+2070.68	+2070.57	+2070.63
23	+ 306.13	+ 306.10	+ 306.12	−2264.63	−2264.40	−2264.52
24	+ 350.53	+ 350.88	+ 350.67	− 53.01	− 52.66	− 52.87
25	+ 412.41	+ 412.30	+ 412.36	+1845.76	+1845.59	+1845.68
26	+ 619.36	+ 619.26	+ 619.31	+2698.46	+2698.48	+2698.47
27	+1078.59	+1078.44	+1078.52	+1073.80	+1073.72	+1073.76
28	+1078.89		+1078.84	+1079.37		+1079.38
30	+1307.09	+1306.98	+1307.04	− 168.49	− 168.33	− 168.41
31	+1377.12	+1376.75	+1376.94	−1964.07	−1963.60	−1963.84
32	+1868.76		+1868.71	−1172.93		−1172.86
35	+1925.26	+1925.12	+1925.19	−2095.67	−2095.60	−2095.64
36	+1924.07	+1924.01	+1924.04	+1992.12	+1992.07	+1992.10
37	+2002.20	+2002.23	+2002.22	−1530.28	−1530.46	−1530.37
38	+2029.67	+2029.66	+2029.66	− 832.39	− 832.31	− 832.35
39	+2223.91		+2223.82	+1844.19		+1844.19
39½	+2296.67		+2296.59	+1398.00		+1398.01
40	+2536.24		+2536.15	+1135.33		+1135.34
41	+2670.11		+2670.02	+ 758.35		+ 758.37
41½	+2731.10		+2731.00	+2396.58		+2396.56
42	+2741.13	+2740.92	+2741.03	+1597.09	+1597.21	+1597.15

pared with these by determining the usual constants p, r, k and c from fifty-six[1] equations of the usual form.

These constants had the following values:

$$\begin{aligned} p &= -0.0000230 \pm 0.0000048 \\ r &= -0.0000089 \pm 0.0000048 \\ k &= -0''.0234 \quad \pm 0''.0109 \\ c &= +0''.0200 \quad \pm 0''.0109 \end{aligned}$$

Probable error of one equation $= \pm 0''.0576$.

The corrections due to these constants were applied to the remaining standard coördinates of Set (3) thereby bringing about their transformation into the Final Coördinates of Series (B).

The averaged and computed Final Coördinates of Series (B) are also given in Table IX. These are now the photographic coördinates derived from the plates of Series (B), fully corrected, and brought into the best possible general agreement with the *Astronomische Gesellschaft* Catalog.

Preliminary Catalog. — The right ascensions and declinations corresponding to the Final Coördinates of Series (B) were now computed. The formulæ used were those of Contrib. 23, p. 6, and are given below, fourth and higher order terms were again omitted in the calculations.

$$\begin{aligned} x' = x &+ J_1xy, & J_1 &= \tan\delta \sin 1'', \\ &+ J_2xy^2, & J_2 &= \tan^2\delta \sin^2 1'', \\ &+ J_3x^3, & J_3 &= -\tfrac{1}{3}(1 + \tan^2\delta)\sin^2 1'', \\ &+ J_4x^3y, & J_4 &= -(\tan\delta + \tan^3\delta)\sin^3 1'', \\ &+ J_5xy^3, & J_5 &= \tan^3\delta \sin^3 1'', \\ &+ J_6x^3y^2, & J_6 &= -2(\tan^2\delta + \tan^4\delta)\sin^4 1'', \\ &+ J_7x^5, & J_7 &= (\tfrac{1}{5} + \tfrac{2}{5}\tan^2\delta + \tfrac{1}{5}\tan^4\delta)\sin^4 1'', \\ &+ J_8xy^4. & J_8 &= \tan^4\delta \sin^4 1''. \end{aligned}$$

$$\begin{aligned} y' = y &+ K'_1x^2. & K'_1 &= -\tfrac{1}{2}\tan\delta \sin 1'', \\ &+ K'_2x^2y, & K'_2 &= -\tfrac{1}{2}(1 + \tan^2\delta)\sin^2 1'', \\ &+ K'_3y^3, & K'_3 &= -\tfrac{1}{3}\sin^2 1'', \\ &+ K'_4x^2y^2, & K'_4 &= -\tfrac{1}{2}\tan^3\delta \sin^3 1'', \\ &+ K'_5x^4, & K'_5 &- (\tfrac{3}{8}\tan\delta + \tfrac{1}{8}\tan^3\delta)\sin^3 1'', \\ &+ K'_6x^4y, & K'_6 &= (\tfrac{3}{8} + \tfrac{3}{4}\tan^2\delta + \tfrac{3}{8}\tan^4\delta)\sin^4 1'', \\ &+ K'_7x^2y^3, & K'_7 &= \tfrac{1}{2}(1 - \tan^4\delta)\sin^4 1''. \end{aligned}$$

In these x' and y', as before, have the following significance:

$$x' = (a' - a)\cos\delta, \quad y' = \delta' - \delta.$$

---

[1] The four equations given by β and β_2 were not used in this solution in order to prevent their large $(X_3 - X_B)$ from having an undue influence on the constants.

The right ascensions and declinations thus obtained are put down in Table X together with the difference between these and the positions given in the first paper on β Cygni[1] taken in the sense new *minus* old.

It will be seen that these check even now very closely, the variation from the mean differences in right ascension and declination exceeding 0″.50 in only six cases and 0″.63 in only one case.

Mean Rectangular Coördinates from Set (1) *and Set* (2).— On pages 341–346 inclusive of the paper just referred to are given the corrected distances and position angles of the stars of Series (A) with reference to β Cygni as center. Averages of these distances and angles were formed for Set (1) and Set (2) and the distances then reduced to seconds of arc by multiplying by 28.0124, which is the average number of seconds per division of the glass scale used in these measures. From the average distances and position angles rectangular coördinates were now computed. These were now referred to β_2 as center, in order to agree with the previous part of the work, and are so given in Table XI.

Standard Coördinates of Series (A).—The mean coördinates for Sets (1) and (2) as given in Table XI were now compared with the Final Coördinates of Series (B) after these also had been referred to β_2 as center. The comparison equations were formed in the usual way and the constants deduced for Set (1) and Set (2) as well as the residuals for the sixty-eight equations of Set (1) and sixty-six equations of Set (2) are given in Table XII. It will be seen that the probable errors of the single equations as well as the residuals themselves are very much smaller than those given in Table VIII, showing, as was to be expected, that the accuracy of the Preliminary Catalog is far greater than that of the *Astronomische Gesellschaft*, at least with respect to the differential coördinates.

The constants just obtained were used to correct the mean coördinates given in Table XI, thus forming the Standard Coör-

---

[1] The Rutherfurd Photographic Measures of the Stars about β Cygni. By H. Jacoby. *Annals N. Y. Acad Sci.*, Vol. VI.

TABLE X. — PRELIMINARY CATALOG AND COMPARISON WITH CATALOG IN FIRST PAPER ON β CYGNI.

Star.	Right Ascension 1875	Difference New — Old.	Declination 1875.	Difference New — Old.
	° ′ ″	″	° ′ ″	″
2	290 30 34.42	+1.16	27 42 5.38	—0.64
3	42 13.72	+1.29	28 9 41.81	—0.61
5	46 40.00	+0.48	28 30 1.55	0.00
6	48 4.46	+1.48	27 40 0.98	—0.47
8	51 56.35	+1.41	27 6 34.50	—0.38
9	53 25.71	+1.14	28 13 49.10	—0.59
11	291 1 0.29	+1.51	27 40 20.66	—0.46
12	4 42.16	+1.68	27 20 34.04	0.27
13	5 2.57	+1.32	27 48 33.23	—0.64
14	10 9.04	+1.30	27 6 20.65	—0.18
15	13 59.82	+0.95	28 27 56.93	—0.56
16	21 59.12	+1.22	26 58 48.67	—0.43
17	23 7.23	+0.94	28 1 11.38	—0.82
18	23 51.61	+1.25	28 4 41.62	—0.70
19	25 13.95	+1.29	27 41 53.48	—0.45
20	25 45.93	+1.33	27 42 13.24	—0.57
21	27 9.77	+0.70	27 19 56.38	—0.24
22	27 25.92	+1.01	28 16 43.85	—0.92
23	31 27.27	+1.12	27 4 28.75	—0.22
24	32 19.52	+0.02	27 41 20.27	—0.68
25	33 31.45	+1.20	28 12 58.71	—0.72
26	37 27.83	+0.86	28 27 11.11	—0.52
27	46 4.99	+0.81	28 0 5.55	—0.63
28	46 5.37	+0.97	28 0 11.17	—0.33
30	50 19.11	+0.55	27 39 22.72	—0.37
31	51 30.96	+0.81	27 9 27.16	—0.26
32	292 0 47.92	+1.56	27 22 36.07	+0.26
35	1 46.34	+0.85	27 7 13.14	—0.58
36	2 7.65	+0.84	28 15 20.52	—0.53
37	3 16.10	+1.66	27 16 37.85	—0.43
38	3 51.02	+0.88	27 28 15.77	—0.41
39	7 46.98	+1.05	28 12 51.01	+0.10
39½	9 6.58		28 5 24.46	
40	13 36.14	+0.80	28 1 0.32	—0.48
41	16 4.85	+0.51	27 54 42.51	—0.13
41½	17 26.81		28 21 59.98	
42	17 31.85	+1.25	28 8 40.68	—0.20

TABLE XI.—CORRECTED RECTANGULAR COÖRDINATES OF SET (1) AND SET (2).

Star.	x_1	y_1	x_2	y_2
1			—3041.48	+ 749.42
2	—2932.18	+ 2.95	—2931.34	+ 1.90
3	—2302.96	+1655.53	—2303.04	+1655.22
4			—2237.90	+2626.29
5	—2061.37	+2873.27	—2061.08	+2872.99
6	—2003.27	— 127.45	—2002.78	— 127.37
7	—1927.44	—1566.48	—1927.04	—1566.54
8	—1806.83	—2135.02	—1806.26	—2134.92
9	—1709.39	+1899.47	—1709.46	+1899.57
10	—1576.47	+3150.90	—1575.33	+3151.51
11	—1315.97	— 110.64	—1315.76	— 110.52
12	—1123.07	—1298.17	—1122.52	—1297.81
13	—1100.15	+ 381.33	—1099.40	+ 381.71
14	— 834.17	—2152.28	— 833.23	—2152.01
15	— 620.30	+2744.45	— 620.96	+2744.49
16	— 202.26	—2604.99	— 201.44	—2604.36
17	— 139.92	+1138.18	— 139.75	+1138.63
18	— 100.91	+1348.36	— 100.87	+1348.67
19	— 28.12	— 19.94	— 28.44	— 19.82
20	0.00	0.00	0.00	0.00
21	+ 74.21	—1337.44	+ 75.35	—1337.06
22	+ 88.20	+2070.74	+ 88.17	+2071.21
23	+ 303.92	—2265.02	+ 304.64	—2264.38
24			+ 349.52	— 52.62
25	+ 410.15	+1845.68	+ 410.23	+1846.04
26	+ 617.34	+2698.18	+ 617.36	+2698.52
27	+1076.72	+1073.61	+1076.75	+1074.24
28	+1077.01	+1078.94	+1076.86	+1079.80
29	+1253.96	—1421.58		
30	+1305.27	— 168.88	+1305.88	— 168.04
31	+1375.02	—1964.04	+1375.84	—1963.73
32	+1866.61	—1173.52		
33	+1871.09	+1968.94	+1870.50	+1969.98
34	+1895.67	+3140.42	+1895.67	+3141.17
35	+1922.94	—2095.75	+1924.03	—2094.67
36	+1922.13	+1991.69	+1922.02	+1992.57
37	+1999.93	—1530.40		
38	+2027.64	— 832.69	+2028.13	— 831.83
39	+2221.70	+1843.20	+2221.71	+1844.37
40	+2534.11	+1134.71	+2534.38	+1136.10
41	+2668.11	+ 757.23	+2668.64	+ 759.01
42	+2738.77	+1596.33	+2738.52	+1597.47

dinates for Sets (1) and (2) designated by X_1, Y_1 and X_2, Y_2 in Table XIII.

Intercomparison of Set (1) *and Set* (2). — This intercomparison was made in an exactly similar manner to that of Set (3) and Set (4). From the sixty-four equations of condition solved by the method of least squares the following constants were deduced:

$$\begin{aligned} p &= -0.00000125 \pm 0.00000730 \\ r &= +0.00000064 \pm 0.00000730 \\ k &= -0''.0085 \quad \pm 0''.0166 \\ c &= +0''.0077 \quad \pm 0''.0166 \end{aligned}$$

Probable error of one equation $= \pm 0''.0927$

As was to be expected these quantities are all extremely small and the corrections due to p and r are entirely inappreciable. The corrections for k and c were applied with the sign given to the stars of Set (1) not appearing in (2), and with the opposite sign to stars that appeared in Set (2) but not in (1). The Final Coördinates of Series (A) are given in columns X_A and Y_A of Table XIII.

Final Coördinates. — The Final Coördinate of Series (A) and (B) were now averaged for all stars appearing in both series and the Final Coördinates of Series (A) were compared with these by a least square solution embodying seventy equations of condition. The constants deduced by this solution were as follows:

$$\begin{aligned} p &= +0.00000127 \pm 0.00000643 \\ r &= +0.00000035 \pm 0.00000643 \\ k &= -0''.0053 \quad \pm 0''.0145 \\ c &= -0''.0025 \quad \pm 0''.0145 \end{aligned}$$

Probable error of one equation $= \pm 0''.0846$

the total correction due to these constants never amounting to more than 0''.01.

The averaged coördinates of Series (A) and (B) together with the corrected coördinates of those stars appearing in only one of the series are given in Table XIV as the Final Coördinates of the stars under consideration.

Magnitudes. — In order to determine the stellar photographic magnitudes the diameters of all the star-images were carefully measured on Plates 5 and 8, six settings being made for each

TABLE XII. — COMPARISON OF SET (1) AND SET (2) WITH PRELIMINARY CATALOG.

Set (1).			Set (2).		
$p = -0.0000160 \pm 0.0000128$ $r = -0.0000868 \pm 0.0000128$ $k = -0''.0203 \pm 0''.0292$ $c = +0''.3415 \pm 0''.0292$ Prob. error of one equ. = ± 0″.1688			$p = -0.0000038 \pm 0.0000168$ $r = +0.0001684 \pm 0.0000168$ $k = -0''.4344 \pm 0''.0378$ $c = -0''.0746 \pm 0''.0378$ Prob. error of one equ. = ± 0″.2141		
Star.	v_x	v_y	Star.	v_x	v_y
	″	″		″	″
2	−0.02	−0.01	2	+0.37	−0.71
3	+0.04	+0.18	3	−0.05	+0.07
5	+0.31	−0.68	5	+0.91	−0.81
6	−0.30	−0.11	6	−0.28	+0.07
8	+0.08	−0.02	8	−0.34	+0.11
9	+0.01	−0.07	9	0.00	+0.09
11	−0.24	−0.03	11	−0.49	+0.02
12	−0.37	−0.26	12	−0.59	−0.04
13	−0.42	+0.04	13	0.00	+0.30
14	+0.03	−0.17	14	−0.02	−0.12
15	+0.26	+0.34	15	−0.10	+0.16
16	+0.08	+0.04	16	−0.20	+0.27
17	+0.07	+0.31	17	+0.12	+0.40
18	−0.18	+0.26	18	−0.20	+0.20
19	+0.17	+0.16	19	−0.57	−0.13
20	−0.02	+0.34	20	−0.43	−0.08
21	−0.18	−0.20	21	+0.19	−0.27
22	−0.05	+0.37	22	+0.05	+0.42
23	+0.12	−0.16	23	−0.16	−0.04
24			24	+0.56	+0.05
25	−0.25	+0.29	25	−0.09	+0.15
26	−0.08	0.00	26	+0.23	−0.20
27	+0.22	+0.21	27	+0.13	+0.15
28	+0.19	−0.08	28	−0.08	+0.09
30	+0.35	−0.07	30	+0.52	+0.01
31	+0.36	+0.23	31	+0.27	−0.26
32	+0.10	−0.20	32		
35	+0.03	+0.37	25	+0.18	+0.51
36	+0.02	+0.01	36	+0.04	−0.01
37	−0.06	+0.45	37		
38	+0.15	+0.13	38	+0.03	+0.04
39	−0.19	−0.54	39	−0.08	−0.35
40	−0.05	−0.15	40	+0.13	+0.18
41	+0.11	−0.64	41	+0.46	+0.04
42	−0.31	−0.33	42	−0.53	−0.30

TABLE XIII. — FINAL COÖRDINATES OF SERIES (A).

Star.	X_1	X_2	X_A	Y_1	Y_2	Y_A
1		−3041.77	−3041.76		+ 749.88	+ 749.87
2	−2932.15	−2931.67	−2931.96	+ 3.04	+ 2.34	+ 2.69
3	−2303.08	−2303.17	−2303.13	+1655.64	+1655.54	+1655.59
4		−2237.86	−2237.85		+2626.60	+2626.59
5	−2061.61	−2061.16	−2061.38	+2873.38	+2873.27	+2873.32
6	−2003.25	−2003.22	−2003.24	− 127.28	− 127.09	− 127.19
7	−1927.29	−1927.63	−1927.46	−1566.27	−1566.26	−1566.26
8	−1806.63	−1807.05	−1806.84	−2134.81	−2134.66	−2134.74
9	−1709.54	−1709.55	−1709.54	+1899.63	+1899.79	+1899.71
10	−1576.74	−1575.10	−1575.92	+3151.05	+3151.70	+3151.38
11	−1315.96	−1316.20	−1316.08	− 110.42	− 110.36	− 110.39
12	−1122.96	−1123.18	−1123.07	−1297.91	− 1297.65	−1297.78
13	−1100.18	−1099.76	−1099.97	+ 381.56	+ 381.83	+ 381.69
14	− 833.99	− 834.03	− 834.01	−2151.98	−2151.93	−2151.96
15	− 620.55	− 620.91	− 620.73	+2744.70	+2744.52	+2744.61
16	− 202.05	− 202.32	− 202.18	−2604.63	−2604.38	−2604.50
17	− 140.04	− 139.98	− 140.01	+1138.49	+1138.58	+1138.54
18	− 101.05	− 101.06	− 101.06	+1348.67	+1348.61	+1348.64
19	− 28.14	− 28.87	− 28.50	− 19.60	− 19.88	− 19.74
20	− 0.02	− 0.43	− 0.22	+ 0.34	− 0.07	+ 0.14
21	+ 74.31	+ 74.69	+ 74.50	−1337.07	−1337.13	−1337.10
22	+ 88.00	+ 88.10	+ 88.05	+2071.06	+2071.11	+2071.08
23	+ 304.10	+ 303.82	+ 303.96	−2264.61	−2264.49	−2264.55
24		+ 349.08	+ 349.09		− 52.75	− 52.76
25	+ 409.96	+ 410.12	+ 410.04	+1846.03	+1845.89	+1845.96
26	+ 617.08	+ 617.40	+ 617.24	+2698.53	+2698.33	+2698.43
27	+1076.59	+1076.51	+1076.55	+1074.02	+1073.98	+1074.00
28	+1076.88	+1076.62	+1076.75	+1079.35	+1079.54	+1079.44
29	+1254.04		+1254.03	−1421.12		−1421.11
30	+1305.25	+1305.41	+1305.33	− 168.43	− 168.34	− 168.38
31	+1375.15	+1375.06	+1375.10	−1963.55	−1964.03	−1963.79
32	+1866.66		+1866.65	−1173.00		−1172.99
33	+1870.87	+1870.40	+1870.64	+1969.41	+1969.57	+1969.49
34	+1895.35	+1895.78	+1895.56	+3140.87	+3140.76	+3140.82
35	+1923.07	+1923.23	+1923.15	−2095.21	−2095.06	−2095.14
36	+1921.91	+1921.93	+1921.92	+1992.17	+1992.16	+1992.16
37	+2000.01		+2000.00	−1529.87		−1529.86
38	+2027.66	+2027.55	+2027.60	− 832.16	− 832.25	− 832.20
39	+2221.48	+2221.59	+2221.54	+1843.70	+1843.90	+1843.80
40	+2533.95	+2534.14	+2534.04	+1135.25	+1135.59	+1135.42
41	+2667.98	+2668.33	+2668.16	+ 757.79	+ 758.48	+ 758.14
42	+2738.57	+2738.36	+2738.46	+1596.88	+1596.91	+1596.90

TABLE XIV.—FINAL COÖRDINATES.

Star.	X_f	Y_f	Star.	X_f	Y_f
1	−3041.77	+ 749.87	23	+ 303.96	−2264.50
2	−2932.04	+ 2.87	24	+ 348.80	− 52.78
3	−2303.13	+1655.53	25	+ 410.12	+1845.85
4	−2237.86	+2626.59	26	+ 617.20	+2698.48
5	−2061.65	+2873.70	27	+1076.46	+1073.91
6	−2003.10	− 127.18	28	+1076.72	+1079.44
7	−1927.47	−1566.26	29	+1254.03	−1421.11
8	−1806.78	−2134.76	30	+1305.11	− 168.36
9	−1709.55	+1899.70	31	+1374.94	−1963.78
10	−1575.93	+3151.38	32	+1866.60	−1172.90
11	−1315.90	− 110.38	33	+1870.64	+1969.49
12	−1122.83	−1297.71	34	+1895.56	+3140.82
13	−1099.87	+ 381.61	35	+1923.10	−2095.36
14	− 834.02	−2151.88	36	+1921.90	+1992.16
15	− 620.77	+2744.48	37	+2000.04	−1530.08
16	− 202.16	−2604.58	38	+2027.56	− 832.24
17	− 140.06	+1138.36	39	+2221.60	+1844.02
18	− 100.96	+1348.52	39½	+2294.44	+1398.07
19	− 28.40	− 19.75	40	+2534.02	+1135.41
20	− 0.11	+ 0.07	41	+2668.02	+ 758.28
21	+ 74.50	−1336.98	41½	+2728.85	+2396.62
22	+ 88.05	+2070.88	42	+2738.67	+1597.06

star on both the plates. The average results of these measures are set down in Table XV, in which the quantities are expressed in revolutions of the micrometer screw, equivalent to half-millimeters.

These diameters were to be compared with the *Astronomische Gesellschaft* Catalog[1] magnitudes by determining two constants a and b such that the photographic magnitude m can be computed from the diameters D of the star images by the formula

$$m = a - b \log D.$$

Before doing this, however, it was thought advisable to exclude such stars whose photographic magnitudes differed decidedly from the visual magnitudes. For this purpose a weighted mean value for a and b was determined from previous magnitude determinations of Rutherford plates, and with these values amounting to

$$a = +14.8, \qquad b = -5.4.$$

the magnitudes of the stars were calculated.

---

[1] For stars 1, 4, 13, 18 and 39, *B.D.* Mags. were used as these stars as well as 28, 32, 33, and 41, are not given in the *A.G.C.*

Table XV. — Diameters of Star-Images.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r
1	0.082	16	0.155	31	0.137
2	0.114	17	0.140	32	0.136
3	0.126	18	0.124	33	0.114
4	0.120	19	0.396	34	0.143
5	0.104	20	0.338	35	0.156
6	0.167	21	0.123	36	0.148
7	0.130	22	0.144	37	0.136
8	0.168	23	0.168	38	0.152
9	0.138	24	0.109	39	0.112
10	0.117	25	0.133	39½	0.103
11	0.158	26	0.194	40	0.122
12	0.147	27	0.182	41	0.112
13	0.102	28	0.118	41½	0.100
14	0.168	29	0.134	42	0.186
15	0.112	30	0.128		

This preliminary solution showed that stars 8, 14, 15, 19 and 20, had best be excluded from the least square solution, for a and b, as their photographic magnitudes differed by more than 0.4 mag. from the visual.

Thirty-four equations of the form

$$a + \log(100D)\, b - m = 0$$

were now solved for a and b and the following values found:

$$a = +13.60 \pm 0.37, \qquad b = -4.24 \pm 0.35.$$

The photographic magnitudes given in the Final Catalog were computed with these constants. It will be noted that although the actual values of a and b as determined by the least square solution differ from the means above given, the sum $a + b$ agrees very closely in the two cases.

Final Catalog. — In Table XVI is given the Final Photographic Catalog. The right ascensions and declinations were computed by the same formulæ with which the preliminary places were determined, while the precessions and secular variations were calculated with the aid of Becker's "Tafeln zur Berechnung der Præcession," suitable corrections being applied to reduce the epoch to 1875.0. The numbers of the stars correspond to those given in Jacoby's discussion of the first six negatives. Stars 39½ and 41½ were not measured on these plates and weré inserted between the original numbers so as to avoid any changes.

Discussion of Results. — As is indicated by the probable errors of the single equations throughout the work, the micrometric positions of the surrounding stars with respect to β and β_2 (Nos. 19 and 20) are of a very much higher degree of accuracy than the meridian circle places of the *Astronomische Gesellschaft* Catalog.

The comparatively large difference between the position of No. 19 of this Catalog and No. 10049 *A.G.C.* is in all probability due to a systematic error of about $+0^s.08$ in right ascension and $-0''.4$ in declination, in the *A.G.C.* places of the small stars of this region.

The right ascension of No. 10052 *A.G.C.* as given in this Catalog is in all probability a typographical error, and should be read $19^h\ 25^m.42^s.97$.

From the standard coördinates of β_2, (No. 20) for the mean dates of Sets (3) and (4) as given in Table IX, and for the mean dates of Sets (1) and (2) as given in Table XIII, it was not possible to come to any definite conclusion as to the true nature of the photographic displacement of this star. But we are certain that the photographic displacement does exist and if not due to parallax, or a large difference in the relative distances from us, of β and the neighboring stars, it may be due to the difference in the magnitude or spectra of the double star β and the neighboring small stars.

In order to make a thorough enquiry into the nature of the photographic displacement of β Cygni we should have a series of plates taken, at intervals of a few days, during that period of one year in which it may be photographed. As soon as the possibility of obtaining such a series presents itself the work on this subject will be continued.

In conclusion I wish to express my thanks to Professor Jacoby for many helpful suggestions and for securing the publication of the work.

TABLE XVI.—FINAL CATALOG.

No.	Magnitude.		No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
	Vis.	Photo.		In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
				h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	9.3*	9.7	2	19 21 53.603	290 28 24.05	+2.40883	+36.1325	+0.00107	+0.0161	+27 54 31.23	+7.0144	+0.3262	1875.72
2	9.1	9.1	11	22 2.301	30 34.52	.41478	36.2217	.00106	.0159	27 42 5.18	.0263	.3269	1876.11
3	9.0	8.9	14	22 48.915	42 13.73	.40276	36.0414	.00108	.0162	28 9 39.85	.0900	.3248	1876.20
4	9.2*	9.0	1	22 53.429	43 21.43	.39523	35.9284	.00108	.0162	28 25 53.12	.0961	.3238	1875.72
5	9.0	9.3	8	23 6.688	46 40.31	.39354	35.9031	.00110	.0165	28 30 1.16	.1142	.3234	1876.00
6	8.2	8.4	14	23 12.286	48 4.29	+2.41700	+36.2550	+0.00105	+0.0157	27 40 0.96	+7.1218	+0.3265	1876.20
7	9.2	8.9	4	23 18.509	49 37.62	.42818	36.4227	.00104	.0156	27 16 2.37	.1303	.3280	1875.68
8	9.0	8.4	14	23 27.752	51 56.29	.43269	36.4904	.00102	.0153	27 6 34.50	.1429	.3285	1876.20
9	8.7	8.8	14	23 33.715	53 25.72	.40165	36.0248	.00108	.0162	28 13 49.08	.1510	.3242	1876.20
10	8.8	9.1	2	23 43.440	55 51.59	.39203	35.8804	.00110	.0165	28 34 41.10	.1643	.3228	1875.64
11	8.0	8.5	14	24 4.006	291 1 0.09	+2.41779	+36.2668	+0.00106	+0.0159	27 40 20.66	+7.1923	+0.3201	1876.20
12	9.0	8.7	14	24 18.793	4 41.90	.42718	36.4077	.00104	.0156	27 20 33.96	.2124	.3272	1876.20
13	9.3*	9.3	12	24 20.164	5 2.46	.41428	36.2142	.00106	.0159	27 48 33.30	.2143	.3255	1876.10
14	9.0	8.4	13	24 40.603	10 9.04	.43410	36.5115	.00103	.0154	27 6 20.57	.2420	.3280	1876.24
15	8.0	9.2	11	24 55.991	13 59.87	.39658	35.9487	.00109	.0164	28 27 57.06	.2630	.3228	1876.25
16	8.3	8.6	14	25 27.939	21 59.09	+2.43839	+36.5758	+0.00102	+0.0153	26 58 48.75	+7.3064	+0.3281	1876.20
17	8.9	8.7	14	25 32.486	23 7.28	.40976	36.1464	.00107	.0160	28 1 11.56	.3126	.3242	1876.20
18	9.1*	9.0	14	25 35.434	23 51.51	.40819	36.1228	.00108	.0162	28 4 41.73	.3166	.3239	1876.20
19	3.0	6.8	14	25 40.924	25 13.85	.41886	36.2829	.00105	.0158	27 41 53.49	.3240	.3252	1876.20
20	6.7	7.1	14	25 43.054	25 45.81	.41875	36.2812	.00105	.0158	27 42 13.31	.3269	.3252	1876.20
21	8.9	9.0	9	25 48.652	27 9.78	+2.42911	+36 4366	+0.00104	+0.0156	27 19 56.27	+7.3345	+0.3266	1876.14
22	8.9	8.7	13	25 49.729	27 25.92	.40285	36.0428	.00109	.0164	28 16 44.04	.3359	.3230	1876.16
23	8.7	8.4	14	26 5.817	31 27.26	.43650	36.5475	.00103	.0154	27 4 28.71	.3577	.3274	1876.20
24	8.9	9.2	5	26 9.323	32 19.84	.41965	36.2948	.00106	.0159	27 41 20.30	.3625	.3251	1876.36
25	8.9	8.8	14	26 14.090	33 31.35	.40507	36.0760	.00108	.0162	28 12 58.82	.3690	.3231	1876.20

TABLE XVI. — FINAL CATALOG. — *Concluded.*

No.	Magnitude.		No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Preces-sion.	Secular Varia-tion.	Mean Epoch.
	Vis.	Photo.		In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
				h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
26	8.0	8.1	14	19 26 29.859	291 37 27.88	+2.39874	+35.9811	+0.00109	+0.0164	+28 27 11.05	+7.3904	+0.3221	1876.20
27	8.2	8.3	14	27 4.339	46 5.09	.41202	36.1803	.00107	.0160	28 0 5.64	.4371	.3235	1876.20
28		9.1	7	27 4.360	46 5.41	.41198	36.1797	.00107	.0160	28 0 11.17	.4371	.3235	1876.07
29	8.8	8.8	1	27 17.146	49 17.20	.43140	36.4710	.00104	.0156	27 18 30.18	.4545	.3261	1875.57
30	8.8	8.9	14	27 21.291	50 19.36	.42191	36.3286	.00106	.0159	27 39 22.70	.4601	.3247	1876.20
31	8.8	8.8	13	27 26.076	51 31.13	+2.43570	+36.5355	+0.00103	+0.0154	+27 9 27.14	+7.4665	+0.3266	1876.24
32		8.8	4	28 3.198	292 0 47.97	.43040	36.5460	.00104	.0156	27 22 35.96	.5168	.3255	1876.20
33		9.1	2	28 4.623	1 9.35	.40628	36.0942	.00108	.0162	28 14 58.11	.5186	.3222	1875.64
34	9.1	8.7	5	28 6.940	1 44.11	.39724	35.9586	.00110	.0165	28 34 29.07	.5218	.3209	1875.66
35	8.4	8.5	14	28 7.094	1 46.41	.43748	36.5622	.00102	.0153	27 7 13.35	.5220	.3263	1876.20
36	8.9	8.6	13	28 8.512	2 7.67	+2.40619	+36.0928	+0.00108	+0.0162	+28 15 20.51	+7.5240	+0.3221	1876.16
37	9.0	8.8	9	28 13.072	3 16.07	.43330	36.4996	.00104	.0156	27 16 38.16	.5301	.3257	1876.27
38	8.3	8.6	14	28 15.405	3 51.08	.42803	36.4204	.00104	.0156	27 28 15.81	.5333	.3250	1876.20
39	9.4*	9.2	6	28 31.128	7 46.91	.40779	36.1168	.00108	.0162	28 12 50.77	.5544	.3221	1876.02
39½	9.5	9.3	3	28 36.439	9 6.58	.41134	36.1701	.00108	.0162	28 5 24.44	.5617	.3225	1876.41
40	9.0	9.0	5	28 54.411	13 36.16	+2.41373	+36.2060	+0.00106	+0.0159	+28 1 0.31	+7.5859	+0.3226	1876.11
41		9.2	5	29 4.334	16 5.02	.41683	36.2524	.00106	.0159	27 54 42.34	.5993	.3230	1876.11
41½	9.1	9.4	3	29 9.788	17 26.82	.40430	36.0645	.00108	.0162	28 21 59.96	.6067	.3212	1876.41
42	8.2	8.2	14	29 10.107	17 31.60	.41049	36.1574	.00107	.0160	28 8 40.51	.6071	.3220	1876.20

* *B. D.* Magnitude.

VITA.

Morris Francis Weinrich was born in Vienna, Austria, March 27, 1882. In 1885 his parents came to the United States, where he spent his childhood on a ranch in Irondale, Missouri, until 1889, when his parents moved their residence to St. Louis, Missouri, he here receiving his school education at the Smith Academy and the St. Louis Manual Training School, from which latter he graduated in 1899. Hereupon he entered Washington University where he remained one year. In 1900 he continued his studies at Columbia University, receiving the degree of Mech.E. in 1904. The remainder of this year he was in California and Nebraska in connection with the engineering department of the American Beet Sugar Company. During the year 1905 he was with the N. Y. and N. J. Telephone Company until February, 1906, when he was appointed assistant in the department of Engineering Drafting of Columbia University, which position he occupied until July, 1908. During this time he took graduate work under the Faculty of Pure Science, receiving the degree of A.M. in 1907. In April, 1908, he was appointed University Fellow in Astronomy for the year 1908–1909, which position he now holds.

LIST OF

CONTRIBUTIONS FROM THE OBSERVATORY OF COLUMBIA UNIVERSITY, NEW YORK.

Lists of Errata in Contributions from the Observatory of Columbia University will be Found in Contributions 19, p. 68, and 24, p. 74.

No. 1. Lewis Morris Rutherfurd, by John K. Rees. Pp. 15. July, 1906. *Octavo.*

No. 2. A Catalogue of Rutherfurd's Photographic Plates of the Sun, the Moon and the Stars, by John K. Rees. Pp. 7. July, 1906. *Octavo.*

No. 3. The Rutherfurd Photographic Measures of the Group of the Pleiades, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. VI., pp. 239–330. February, 1892. *Octavo.*

No. 4. The Rutherfurd Photographic Measures of the Stars About β Cygni, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. VI., pp. 331–348. May, 1892. *Octavo.*

No. 5. The Parallaxes of μ and θ Cassiopeiæ Deduced from Rutherfurd Photographic Measures, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. VIII., pp. 1–23. March, 1893. *Octavo.*

No. 6. The Parallax of η Cassiopeiæ Deduced from the Rutherfurd Photographic Measures, by Herman S. Davis. Annals of the New York Academy of Sciences, Vol. VIII., pp. 301–321. April, 1895. *Octavo.*

No. 7. The Rutherfurd Photographic Measures of Sixty-Two Stars about η Cassiopeiæ, by Herman S. Davis. Annals of the New York Academy of Sciences, Vol. VIII., pp. 381–416. June, 1895. *Octavo.*

No. 8. Declinations and Proper Motions of Fifty-six Stars, by Herman S. Davis, Ph. D. Memoir I., Part 1, New York Academy of Sciences, pp. 105. June, 1895. *Quarto.*

No. 9. The Variation of Latitude at New York City from Observations by John K. Rees, Harold Jacoby and Herman S. Davis. Memoir I., Part 2, New York Academy of Sciences, pp. 236. July, 1906. *Quarto.*

No. 10. On the Reduction of Stellar Photographs, with Special Reference to the Astro-Photographic Catalogue Plates, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. IX., pp. 101–123. April, 1896. *Octavo.*

No. 11. On the Permanence of the Rutherfurd Photographic Plates, by Harold Jacoby. Annals of the New York Academy of Sciences, Vol. IX., pp. 195–284. October, 1896. *Octavo.*

No. 12. The Rutherfurd Photographic Measures of Sixty-five Stars near 61 Cygni, by Herman S. Davis. Annals of the New York Academy of Sciences. Vol. X., pp. 58–121. August, 1897. *Octavo.*

No. 13. The Parallaxes of 61^1 and 61^2 Cygni Deduced from the Rutherfurd Photographic Measures, by Herman S. Davis. Annals of the New York Academy of Sciences, Vol. X., pp. 123–160. August, 1897. *Octavo.*

No. 14. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THIRTY-FOUR STARS NEAR "BRADLEY 3077," BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences, Vol. X., pp. 161–187. August, 1897. *Octa*

No. 15. THE PRÆSEPE GROUP; MEASUREMENT AND REDUCTION OF THE RUTHERFURD PHOTOGRAPHS, BY FRANK SCHLESINGER. Annals of the Ne York Academy of Sciences, Vol. X., pp. 188–286. May, 1898. *Octa*

No. 16. THE POSITIONS AND PROPER MOTIONS OF THE PRINCIPAL STARS IN THE CLUSTER OF COMA BERENICES AS DEDUCED FROM MEASUREMENTS OF THE RUTHERFURD PHOTOGRAPHS, BY WALTER C. KRE Annals of the New York Academy of Sciences, Vol. XII., pp. 342–47 February, 1900. *Octavo.*

No. 17. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THE GROUP OF TH PLEIADES (Second Paper), BY HAROLD JACOBY. Pp. 24. Januar 1901. *Octavo.*

No. 18. THE PARALLAX OF μ CASSIOPEIÆ AND THE POSITIONS OF 56 NEIGHBORING STARS AS DEDUCED FROM THE RUTHERFURD PHOTOGRAPH MEASURES, BY GEORGE N. BAUER. Pp. 102. April, 1901. *Octa*

No. 19. CATALOGUE OF 287 STARS NEAR THE SOUTH POLE, AND OPTICAL DISTORTION OF THE CAPE OF GOOD HOPE ASTRO-PHOTOGRAPHIC TELESCOPE, BY HAROLD JACOBY. Pp. 70. April, 1902. *Octavo.*

No. 20. The SUMATRA ECLIPSE, 1901. SPECTROGRAPHIC STUDY OF THE FLAS SPECTRUM: NEW GASES IN THE SUN, BY S. A. MITCHELL. Pp. 42 November, 1903. *Octavo.*

No. 21. PHOTOGRAPHIC CATALOGUE OF 829 STARS NEAR THE SOUTH POLE O THE HEAVENS; AN EXAMPLE OF INTER-ADJUSTING OVERLAPPIN PLATES, BY HAROLD JACOBY. Pp. 153. January, 1904. *Octavo.*

No. 22. RESEARCHES AS TO THE IDENTITY OF THE PERIODIC COMET OF 188 1896–1903 (BROOKS) WITH THE PERIODIC COMET OF 1770 (LEXELL), CHARLES LANE POOR. Pp. 82. December, 1904. *Octavo.*

No. 23. TABLES FOR THE REDUCTION OF ASTRONOMICAL PHOTOGRAPHS, HAROLD JACOBY. Pp. 24. February, 1905. *Octavo.*

No. 24. RUTHERFURD PHOTOGRAPHS OF THE STELLAR CLUSTERS h AND χ PERS BY ANNE SEWELL YOUNG. Pp. 76. September, 1906. *Octavo.*

No. 25. RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING 59 CYGNI, HAROLD JACOBY. Pp. 23. April, 1908. *Octavo.*

No. 26. AN INVESTIGATION OF THE FIGURE OF THE SUN AND OF POSSIBLE VA TIONS IN ITS SIZE AND SHAPE, BY CHARLES LANE POOR. Anna The New York Academy of Sciences, Vol. XVIII, No. 9, Part pp. 385-424. August, 1908. *Octavo.*

No. 27. RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING β CYGNI MORRIS FRANCIS WEINRICH. Pp. 34. April, 1909. *Octavo.*

* Contributions numbered 1 to 7 and 10 to 15 (inclusive) have been gathered togethe volume of 614 pages entitled RUTHERFURD: STELLAR PHOTOGRAPHS: VOL. I.; PLEIA CYGNUS: CASSIOPEIÆ: PRÆSEPE, by REES, JACOBY, DAVIS AND SCHLESINGER, 1898

The volume is supplied with a consecutive pagination, table of contents and a preface

Only a few volumes have been distributed because of the scarcity of several of the pa

Beginning with No. 16 all contributions relating to the Rutherfurd Photographs w paged consecutively at the bottom of the pages, and in due time will be assembled in a se Rutherfurd volume.

52015
C72c

UNIV. O
OCT 1

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—No. 28
HAROLD JACOBY, Director

RUTHERFURD PHOTOGRAPH
OF STARS SURROUNDING
η, 27, 34, γ, ν and 71 CYGNI

BY

HAROLD JACOBY

PUBLISHED FROM THE
RUTHERFURD STUYVESANT FUND
NEW YORK
1910

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—No. 28
HAROLD JACOBY, Director

RUTHERFURD PHOTOGRAPHS OF STARS SURROUNDING η, 27, 34, γ, ν and 71 CYGNI

BY

HAROLD JACOBY

PUBLISHED FROM THE
RUTHERFURD STUYVESANT FUND
NEW YORK
1910

PRESS OF
THE NEW ERA PRINTING COMPANY
LANCASTER, PA

PREFATORY NOTE.

The series of Rutherfurd star-plate publications commenced some twenty years ago is brought to completion in the present memoir; it is hoped the results will be found useful by astronomers.

HAROLD JACOBY,
Rutherfurd Professor of Astronomy.

COLUMBIA UNIVERSITY,
August, 1910.

RUTHERFURD PHOTOGRAPHS

STARS SURROUNDING η, 27, 34, γ, ν AND 71 CYGNI.

The publication by Columbia University Observatory of results derived from Rutherfurd's star photographs was begun in 1892 with the Pleiades group,[1] and has since continued in the series "Contributions from the Observatory of Columbia University." The present paper concludes this piece of work. All satisfactory star-group negatives contained in the Rutherfurd collection have now been measured and computed. Only those were omitted for which the plates are distinctly inferior, too few in number, or show but a very small cluster of star-images.

The method of procedure has been identical for all star-groups discussed in the present paper, and corresponds exactly with that employed for 59 Cygni.[2] For convenience, a brief description of the method of procedure is repeated here. The computations have been planned in such a way that they fall naturally in two parts: first, an intercomparison of the separate plates; second, a deduction of mean results derived from the photographs, using the *Astronomische Gesellschaft* Catalog as a standard. Tables appended to the present paper summarize the several steps of the work.

Table I gives in customary form various details inscribed upon the plates by Rutherfurd himself. The "sidereal time" is the mean of the four instants of beginning and ending for two exposures: as usual, Rutherfurd made two complete pictures on each plate. Of the three thermometers used, the first was attached to the mercurial barometer, the second was in the open air, and the third was fastened to the telescope tube. The column "focus" contains readings of a micrometer on the plate end of the telescope, intended to indicate the variations of distance between the plate-holder and object glass.

---

[1] Jacoby. Contributions from the Observatory of Columbia College, No. 3.

[2] Jacoby. Contributions from the Observatory of Columbia University, No. 25.

The measures were made with the usual Repsold machine in rectangular coördinates, both images of each star being observed in direct and reversed positions of the plate. Instrumental corrections were applied to the measures as follows:

1. Screw errors of the microscope.
2. Runs.
3. Division errors of the measuring machine scale.
4. "Rotation corrections" to render the two coördinates perfectly rectangular.

The final coördinates, thus fully corrected for all instrumental errors are set down in Table II.

The coördinates of Table II were next changed from millimeters to seconds of arc approximately with the scale value 1 mm. = 52″.87. They can be corrected for refraction with the following notation and formulæ:

φ = Latitude of Rutherfurd's observatory.

θ = Sidereal time from Table I.

α and δ = Right ascension and declination of the plate center approximately.

β = The usual refraction constant multiplied by $\frac{66}{65}$ to allow for the difference between photographic and visual refractions.

If we then compute the auxiliary quantities:

$$
\begin{aligned}
\tan N &= \cot \phi \cos(\theta - \alpha), \\
G &= \cot(\delta + N), \\
H &= \tan(\theta - \alpha) \sin N \operatorname{cosec}(\delta + N), \\
M_x &= \beta(1 + H^2) \sin 1'', \\
N_x &= \beta(GH - H \tan \delta) \sin 1'', \\
M_y &= \beta(GH + H \tan \delta) \sin 1'', \\
N_y &= \beta(1 + G^2) \sin 1'',
\end{aligned}
$$

the refraction corrections required by the measured coördinates in Table II, are:

$$
\begin{aligned}
&\text{for } X, \quad M_x X + N_x Y, \\
&\text{for } Y, \quad M_y X + N_y Y.
\end{aligned}
$$

The refraction coefficients M_x, N_x, M_y, N_y are tabulated in Table III for the various plates.

The next step was an intercomparison of the plates of each star-group, using all the stars occurring on all the plates; for each of these the X's and Y's from Table II, corrected for refraction, were combined into arithmetical means. This gave us pairs of mean coördinates belonging to an imaginary mean plate. We then corrected the coördinates of each plate in such a way as to bring about the best possible agreement of that plate with the imaginary mean plate. For this purpose, we let:

p = a correction required by the assumed scale-value $52''.87$ for the plate in question.

r = a small angle through which the coördinate axes of the plate must be rotated.

k, c = corrections of the plate-center in X and Y.

Then for each star common to all plates of any star-group there is a pair of equations of the form:

$$
\begin{aligned}
pX + rY + k &= x - X,\\
pY - rX + c &= y - Y,
\end{aligned}
$$

where the right-hand members are the coördinate differences between the mean plate and each individual plate, taken in the sense mean *minus* plate. A least squares solution of these equations for each plate gave results contained in Table IV; and these values of p, r, k and c are suitable for the reduction of each individual plate to the mean plate. This reduction was carried out by simply adding to the measured coördinates of all stars, whether common to all the plates or not, corrections for refraction and corrections based on Table IV. In other words, we corrected the measured coördinates of Table II as follows:

$$
\begin{aligned}
&\text{for } X, \quad (p + M_x)X + (r + N_x)Y + k,\\
&\text{for } Y, \quad (-r + M_y)X + (p + N_y)Y + c.
\end{aligned}
$$

Means of these corrected coördinates were then formed for all stars. These means for stars common to all plates of any group coincided of course with the mean-plate coördinates already obtained for these stars, on account of the method by which p, r, k and c were obtained. For the remaining stars this method constitutes a reduction to the mean system of all plates, even though these stars are lacking on certain plates.

Having thus reduced all coördinates to a mean system, Table V was formed. This table gives the arithmetical averages of all coördinates reduced as above, with the differences between each plate and the average, taken in the sense plate *minus* average.

The mean coördinates of Table V were next corrected in such a way as to bring about the best possible agreement with the star places in the *Astronomische Gesellschaft* Catalog. Table VI shows which stars are common to the *Astronomische Gesellschaft* Catalog and to Table V.

Our method of procedure was that published in "Tables for the Reduction of Astronomical Photographs." In this method,[3] rectangular coördinates x, y, are computed from the *Astronomische Gesellschaft* Catalog places, and then a series of equations are solved, similar to those used in the comparison of each plate with the mean plate. These equations are of the form

$$pX + rY + k + (X - x) = 0,$$
$$pY - rX + c + (Y - y) = 0;$$

in which X, Y, are the mean coördinates of Table V and x, y those computed from the *Astronomische Gesellschaft* Catalog. It will be seen that p, r, k, c, are now plate-constants suitable for bringing about the best possible agreement between the mean of all our photographs and the *Astronomische Gesellschaft* Catalog.

A solution of all available equations of this form gave results and residuals contained in Table VII. The probable error of one equation, and the residuals are much larger than those of Table IV, but they now include of course the rather large errors of the meridian circle places. In these computations attention was paid to proper motion, when the epochs of the plates and the *Astronomische Gesellschaft* Catalog were not nearly the same, and when proper motions are known.

With the values of p, r, k, c, from Table VII we next corrected the mean coördinates of Table V, giving the final coördinates of Table VIII. These are now photographic coördinates of all stars, fully corrected, and brought into the best possible general agreement with the *Astronomische Gesellschaft* Catalog.

[3] Jacoby. Contributions from the Observatory of Columbia University, No. 23.

To determine next the stellar photographic magnitudes, the diameters of all star-images were measured on the best plate of each group; the results are set down in Table IX, in which the quantities are expressed in revolutions of the micrometer screw, equivalent to half-millimeters. A comparison was made with the *Astronomische Gesellschaft* Catalog magnitudes, and two constants a, b, determined, such that the photographic magnitude m can be computed from the diameters D of the star-images by the formula

$$m = a - b \log D.$$

The values of a and b that produce the best possible agreement with the Astronomische Gesellschaft magnitudes were found to be:

$$\begin{aligned}
&\text{For } \eta \text{ Cygni}, && a = +15.11(\pm 0.77),\ b = +5.49(\pm 0.62) \\
& && M = 15.11 - 5.49 \log D. \\
&\text{For 27 Cygni}, && a = +13.99(\pm 0.65),\ b = +4.77(\pm 0.56) \\
& && M = 13.99 - 4.77 \log D. \\
&\text{For 34 Cygni}, && a = +13.02(\pm 0.65),\ b = +3.86(\pm 0.54) \\
& && M = 13.02 - 3.86 \log D. \\
&\text{For } \gamma \text{ Cygni}, && a = +17.60(\pm 0.70),\ b = +7.82(\pm 0.58) \\
& && M = 17.60 - 7.82 \log D. \\
&\text{For } \nu \text{ Cygni}, && a = +14.71(\pm 0.68),\ b = +5.15(\pm 0.53) \\
& && M = 14.71 - 5.15 \log D. \\
&\text{For 71 Cygni}, && a = +16.44(\pm 1.15),\ b = +6.84(\pm 0.96) \\
& && M = 16.44 - 6.84 \log D.
\end{aligned}$$

We next collected in Table X a final photographic catalog. The right ascensions and declinations were computed from the photographic final coördinates of Table VIII by the formulæ of Contrib., 23, p. 6; the photographic magnitudes by the formula just given, and the precessions with the usual constants.

TABLE I.—PHOTOGRAPHS OF η CYGNI.

OBSERVATORY OF L. M. RUTHERFURD, NEW YORK.

Lat. 40° 43′ 48″.5 Long. $4^h\ 55^m\ 56^s.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Zen. Dist.
				Att.	Ext.	Tel.		
		h m s	in.					°
1	1875 July 21	17 26 52	30.000	76°	75°	77°	7.5	29.0
2	1875 July 21	17 13 52	30.190	72	70	72	7.64	31.5
3	1875 July 24	17 48 52	30.190	72	70	72	7.64	24.9
4	1875 Sept. 23	21 44 22	30.406	56	56	58	7.7	23.0
5	1875 Sept. 23	22 14 32	30.406	56	56	58	7.7	28.7
6	1875 Sept. 23	22 42 28	30.406	56	56	58	7.7	34.0
10	1876 June 21	15 39 28	30.068	69	67	70	7.6	43.5
12	1876 Dec. 3	0 13 52	30.070	30	28	30	8.0	51.0
13	1876 Dec. 5	23 53 32	30.120	33	32	35	7.95	47.3

TABLE II.—η CYGNI CORRECTED COÖRDINATES.

PLATE 1.

Star.	*X*	*Y*
5	—43.5004	+ 2.9440
7	—41.1768	— 2.1142
10	—37.0504	+52.6412
12	—35.8004	—33.4780
13	—32.6655	—42.1140
15	—31.8853	—46.5295
16	—31.1472	—36.3823
18	—27.9141	—39.6963
21	—20.9082	— 5.0155
25	—18.4522	—12.2819
29	— 7.4913	— 6.3870
30	— 3.9548	+50.4284
31	— 2.8352	+30.7070
32	— 1.6855	+19.8460
34	— 0.8114	+10.4771
35	0.0000	0.0000
36	+ 0.4827	+24.3057
38	+ 1.9754	+47.9880
39	+ 2.9176	— 7.9301
40	+ 2.9737	—13.8730
42	+ 4.8638	+32.7937
45	+ 8.3545	+30.6019
47	+ 9.7289	+56.0930
48	+10.2692	+51.9600
49	+11.2982	+ 5.9106
50	+12.4640	—27.4599
51	+12.6478	— 3.7326
52	+13.5103	—34.3526
53	+17.5121	—12.3562
56	+20.4673	—57.2587
57	+20.7363	— 3.5783
59	+25.1224	+19.8181
60	+26.2700	—45.3158
62	+28.5716	+ 8.7342
63	+28.5908	+ 7.6810
64	+29.2434	—39.1946
65	+30.1726	+54.0176
68	+32.4677	— 1.3679
71	+35.5805	+ 1.0321
73	+35.6049	+27.7478
74	+35.9949	—29.1011
75	+38.3919	+ 8.1324
76	+39.2638	+30.4024
77	+39.3336	+30.3640
78	+41.7347	+52.5432
79	+43.8629	—40.6956
80	+43.6247	+45.0974
83	+48.8812	+14.8894
84	+50.4151	+13.9927

PLATE 2.

Star.	*X*	*Y*
5	—43.4998	+ 2.9554
6	—42.3727	—10.9642
7	—41.1800	— 2.1003
8	—39.4156	— 8.0734
10	—37.0370	+52.6557
12	—35.8100	—33.4652
13	—32.6796	—42.1076
14	—32.2271	+ 2.3650
15	—31.9000	—46.5168
16	—31.1581	—36.3711
18	—27.9282	—39.6938
20	—23.2556	—20.1638
21	—20.9063	— 5.0118
22	—19.4828	+50.2478
23	—19.2487	— 9.9266
24	—18.6481	+30.6596
25	—18.4488	—12.2748
26	—17.8584	+27.5218
27	— 9.4441	— 9.7906
28	— 9.3648	—25.3477
29	— 7.4910	— 6.3870
30	— 3.9415	+50.4249
31	— 2.8263	+30.7066
32	— 1.6785	+19.8443
34	— 0.8114	+10.4748
35	0.0000	0.0000
36	+ 0.4906	+24.3011
38	+ 1.9876	+47.9849
39	+ 2.9182	— 7.9335
40	+ 2.9608	—13.8745
42	+ 4.8730	+32.7906
45	+ 8.3636	+30.5982
47	+ 9.7498	+56.0833
48	+10.2891	+51.9604
49	+11.3030	+ 5.9048
50	+12.4602	—27.4687
51	+12.6526	— 3.7362
52	+13.4996	—34.3552
53	+17.5074	—12.3668
55	+20.0336	+ 8.2226
57	+20.7348	— 3.5898
58	+23.4119	—24.7530
59	+25.1278	+19.8098
60	+26.2573	—45.3279
62	+28.5662	+ 8.7219
63	+28.5929	+ 7.6718
64	+29.2310	—39.2050
65	+30.1894	+54.0002
66	+30.7435	+36.3749
68	+32.4671	— 1.3774
69	+32.2900	+35.6872
71	+35.5788	+ 1.0188
72	+35.7731	—17.5699
73	+35.6090	+27.7393
74	+35.9924	—29.1217
75	+38.3860	+ 8.1159
76	+39.2652	+30.3869
77	+39.3422	+30.3498
78	+41.7499	+52.5196
79	+43.8487	—40.7041
80	+43.6337	+45.0781
81	+43.8920	+54.8572
83	+48.8871	+14.8746
84	+50.4142	+13.9764
85	+55.8187	+18.1725

PLATE 3.

Star.	*X*	*Y*
1	—56.4492	—20.7132
2	—53.1049	+36.8724
3	—49.1034	+ 4.5326
4	—48.1565	—35.5708
5	—43.5019	+ 2.9383
6	—42.3771	—10.9705
7	—41.1782	— 2.1182
8	—39.4109	— 8.0866
9	—37.9928	+ 7.0791
10	—37.0605	+52.6361
11	—36.1615	—33.9978
12	—35.7986	—33.4806
13	—32.6588	—42.1155
14	—32.2360	+ 2.3642
15	—31.8784	—46.5304
16	—31.1420	—36.3821
17	—30.1518	+50.9848
18	—27.9062	—39.7038
19	—24.1392	+22.2341
20	—23.2410	—20.1660
21	—20.9108	— 5.0165
22	—19.5103	+50.2351
23	—19.2431	— 9.9314
24	—18.6654	+30.6532
25	—18.4508	—12.2815
26	—17.8881	+27.5124
27	— 9.4337	— 9.7920
28	— 9.3540	—25.3468
29	— 7.4896	— 6.3872
30	— 3.9659	+50.4260

TABLE II.—η CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 3.

Star.	X	Y
31	− 2.8400	+30.7056
32	− 1.6900	+19.8462
33	− 1.0044	−58.2994
34	− 0.8156	+10.4779
35	0.0000	0.0000
36	+ 0.4765	+24.3036
37	+ 1.0893	+55.2156
38	+ 1.9670	+47.9882
39	+ 2.9182	− 7.9286
40	+ 2.9692	−13.8722
41	+ 3.0225	+ 2.7962
42	+ 4.8558	+32.7946
43	+ 5.3070	+41.7383
44	+ 7.1120	+64.7916
45	+ 8.3514	+30.6033
46	+ 9.4910	−10.5109
47	+ 9.7186	+56.0936
48	+10.2657	+51.9638
49	+11.2940	+ 5.9094
50	+12.4722	−27.4588
51	+12.6496	− 3.7319
52	+13.5129	−34.3515
53	+17.5119	−12.3578
54	+18.2346	−35.2173
55	+20.0356	+ 8.2368
56	+20.4713	−57.2571
57	+20.7375	− 3.5788
58	+23.4185	−24.7466
59	+25.1174	+19.8228
60	+26.2733	−45.3110
61	+28.5164	+13.7235
62	+28.5646	+ 8.7359
63	+28.5888	+ 7.6866
64	+29.2493	−39.1916
65	+30.1694	+54.0180
66	+30.7296	+36.3954
67	+32.2207	−34.9174
68	+32.4694	− 1.3650
69	+32.2789	+35.7072
70	+34.3664	+36.2389
71	+35.5808	+ 1.0381
72	+35.7856	−17.5449
73	+35.5984	+27.7546
74	+35.9877	−29.1030
75	+38.3866	+ 8.1370
76	+39.2489	+30.4043
77	+39.3305	+30.3674
78	+41.7299	+52.5345
80	+43.6166	+45.1046
81	+43.8704	+54.8866
82	+46.9960	+49.3782
83	+48.8810	+14.8982
84	+50.4140	+13.9978
85	+55.8079	+18.2050
86	+57.1492	−42.6827

PLATE 4.

Star.	X	Y
1	−56.4186	−20.7142
2	−53.0888	+36.8649
3	−49.0752	+ 4.5219
4	−48.1238	−35.5727
5	−43.4836	+ 2.9364
6	−42.3459	−10.9732
7	−41.1587	− 2.1202
8	−39.3884	− 8.0874
9	−37.9684	+ 7.0810
10	−37.0511	+52.6360
11	−36.1272	−33.9995
12	−35.7696	−33.4871
13	−32.6284	−42.1170
14	−32.2086	+ 2.3590
15	−31.8427	−46.5245
16	−31.1075	−36.3816
17	−30.1420	+50.9887
18	−27.8778	−39.6973
19	−24.1206	+22.2320
20	−23.2156	−20.1636
21	−20.8826	− 5.0130
22	−19.4938	+50.2350
23	−19.2164	− 9.9248
24	−18.6502	+30.6584
25	−18.4240	−12.2782
26	−17.8669	+27.5165
27	− 9.4052	− 9.7850
28	− 9.3266	−25.3478
29	− 7.4629	− 6.3802
30	− 3.9584	+50.4293
31	− 2.8271	+30.7129
32	− 1.6707	+19.8533
33	− 0.9660	−58.2909
34	− 0.7920	+10.4829
35	0.0000	0.0000
36	+ 0.4934	+24.3096
37	+ 1.0944	+55.2354
38	+ 1.9759	+47.9937
39	+ 2.9460	− 7.9198
40	+ 2.9983	−13.8648
41	+ 3.0416	+ 2.8016
42	+ 4.8688	+32.8019
43	+ 5.3113	+41.7422
44	+ 7.1132	+64.7955
45	+ 8.3653	+30.6125
46	+ 9.5166	−10.5022
47	+ 9.7254	+56.1069
48	+10.2728	+51.9726
49	+11.3177	+ 5.9212
50	+12.4957	−27.4492
51	+12.6700	− 3.7218
52	+13.5402	−34.3379
53	+17.5423	−12.3460
54	+18.2586	−35.1997
55	+20.0534	+ 8.2478
56	+20.5080	−57.2411
57	+20.7645	− 3.5656
58	+23.4459	−24.7283
59	+25.1355	+19.8343
60	+26.3079	−45.2986
61	+28.5329	+13.7312
62	+28.5888	+ 8.7477
63	+28.6104	+ 7.6990
64	+29.2818	−39.1795
65	+30.1793	+54.0344
66	+30.7414	+36.4084
67	+32.2580	−34.9039
68	+32.4906	− 1.3489
69	+32.2918	+35.7175
70	+34.3802	+36.2606
71	+35.6014	+ 1.0518
72	+35.8123	−17.5349
73	+35.6094	+27.7637
74	+36.0211	−29.0830
75	+38.4008	+ 8.1511
76	+39.2661	+30.4175
77	+39.3406	+30.3820
78	+41.7485	+52.5612
79	+43.8999	−40.6677
80	+43.6304	+45.1193
83	+48.8967	+14.9131
84	+50.4296	+14.0148
85	+55.8238	+18.2248

TABLE II.—η CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 5.			PLATE 5.			PLATE 6.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
1	−56.4202	−20.7242	51	+12.6714	− 3.7177	29	− 7.4652	− 6.3775
2	−53.0978	+36.8642	52	+13.5437	−34.3337	30	− 3.9650	+50.4339
3	−49.0741	+ 4.5174	53	+17.5356	−12.3430	31	− 2.8299	+30.7159
4	−48.1194	−35.5787	54	+18.2665	−35.1969	32	− 1.6749	+19.8525
5	−43.4836	+ 2.9322	55	+20.0473	+ 8.2532	34	− 0.8007	+10.4862
6	−42.3448	−10.9798	56	+20.5114	−57.2362	35	0.0000	0.0000
7	−41.1593	− 2.1243	57	+20.7551	− 3.5652	36	+ 0.4918	+24.3104
8	−39.3871	− 8.0878	58	+23.4442	−24.7264	38	+ 1.9668	+47.9967
9	−37.9779	+ 7.0762	59	+25.1253	+19.8405	39	+ 2.9439	− 7.9188
10	−37.0670	+52.6343	60	+26.3096	−45.2936	40	+ 2.9934	−13.8613
11	−36.1162	−34.0016	61	+28.5239	+13.7393	42	+ 4.8654	+32.8032
12	−35.7604	−33.4900	62	+28.5824	+ 8.7574	44	+ 7.1043	+64.7995
13	−32.6199	−42.1221	63	+28.6058	+ 7.7048	45	+ 8.3571	+30.6118
14	−32.2141	+ 2.3564	64	+29.2844	−39.1733	47	+ 9.7160	+56.1059
15	−31.8349	−46.5278	65	+30.1690	+54.0415	48	+10.2641	+51.9750
16	−31.1026	−36.3840	66	+30.7402	+36.4177	49	+11.3178	+ 5.9240
17	−30.1567	+50.9814	67	+32.2538	−34.9060	50	+12.4950	−27.4468
18	−27.8707	−39.7010	68	+32.4849	− 1.3439	51	+12.6712	− 3.7185
19	−24.1364	+22.2253	69	+32.2774	+35.7235	52	+13.5396	−34.3352
20	−23.2148	−20.1701	70	+34.3681	+36.2618	56	+20.5070	−57.2395
21	−20.8866	− 5.0154	71	+35.5974	+ 1.0582	57	+20.7536	− 3.5652
22	−19.5178	+50.2321	72	+35.8118	−17.5290	59	+25.1252	+19.8351
23	−19.2150	− 9.9288	73	+35.5962	+27.7718	60	+26.3042	−45.2958
24	−18.6568	+30.6559	74	+36.0203	−29.0817	63	+28.6040	+ 7.7039
25	−18.4259	−12.2787	75	+38.3967	+ 8.1570	64	+29.2792	−39.1746
26	−17.8794	+27.5148	76	+39.2559	+30.4299	65	+30.1702	+54.0388
27	− 9.4096	− 9.7858	77	+39.3312	+30.3888	66	+30.7309	+36.4059
28	− 9.3284	−25.3465	78	+41.7259	+52.5630	68	+32.4853	− 1.3492
29	− 7.4631	− 6.3811	79	+43.8992	−40.6584	69	+32.2777	+35.7162
30	− 3.9712	+50.4308	80	+43.6203	+45.1362	71	+35.5924	+ 1.0520
31	− 2.8352	+30.7134	82	+46.9984	+49.4106	73	+35.6006	+27.7650
32	− 1.6799	+19.8548	83	+48.8941	+14.9222	75	+38.3926	+ 8.1541
33	− 0.9576	−58.2968	84	+50.4259	+14.0226	76	+39.2578	+30.4202
34	− 0.7992	+10.4871				77	+39.3351	+30.3830
35	0.0000	0.0000		PLATE 6.		78	+41.7316	+52.5543
36	+ 0.4881	+24.3122				80	+43.6203	+45.1256
37	+ 1.0798	+55.2317	1	−56.4158	−20 7146	81	+43.8637	+54.9020
38	+ 1.9616	+47.9956	5	−43.4804	+ 2.9391	82	+46.9986	+49.4027
39	+ 2.9428	− 7.9204	7	−41.1554	− 2.1170	83	+48.8898	+14.9154
40	+ 2.9965	−13.8650	10	−37.0541	+52.6375	84	+50.4223	+14.0149
41	+ 3.0510	+ 2.8112	11	−36.1240	−33.9972	85	+55.8057	+18.2284
42	+ 4.8594	+32.8043	12	−35.7661	−33.4809			
43	+ 5.3053	+41.7432	13	−32.6256	−42.1108			
45	+ 8.3520	+30.6128	15	−31.8396	−46.5196			
46	+ 9.5118	−10.5016	16	−31.1018	−36.3780			
47	+ 9.7064	+56.1119	18	−27.8702	−39.6972			
48	+10.2578	+51.9781	21	−20.8834	− 5.0126			
49	+11.3116	+ 5.9238	24	−18.6518	+30.6628			
50	+12.4987	−27.4450	25	−18.4242	−12.2764			

TABLE II.—η CYGNI CORRECTED COÖRDINATES.—*Concluded.*

PLATE 10.			PLATE 12.			PLATE 13.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
5	−43.4848	+ 2.9636	5	−43.4737	+ 2.8940	5	−43.4776	+ 2.9215
7	−41.1669	− 2.0950	7	−41.1402	− 2.1593	7	−41.1528	− 2.1385
10	−37.0054	+52.6516	10	−37.1222	+52.5912	10	−37.0820	+52.6175
12	−35.8039	−33.4468	12	−35.7108	−33.5124	12	−35.7398	−33.4937
13	−32.6765	−42.0834	13	−32.5576	−42.1366	13	−32.5937	−42.1238
15	−31.8976	−46.4957	15	−31.7750	−46.5478	15	−31.8110	−46.5354
16	−31.1540	−36.3545	16	−31.0494	−36.4024	16	−31.0755	−36.3876
21	−20.9004	− 5.0004	21	−20.8793	− 5.0346	21	−20.8765	− 5.0217
25	−18.4449	−12.2619	25	−18.4070	−12.2940	24	−18.6709	+30.6434
29	− 7.4851	− 6.3775	29	− 7.4585	− 6.3854	25	−18.4170	−12.2827
30	− 3.9251	+50.4274	30	− 4.0381	+50.4214	29	− 7.4624	− 6.3813
31	− 2.8289	+30.7101	31	− 2.8806	+30.7090	30	− 3.9982	+50.4246
34	− 0.8082	+10.4816	34	− 0.8169	+10.4812	31	− 2.8501	+30.7126
35	0.0000	0.0000	35	0.0000	0.0000	32	− 1.6919	+19.8476
38	+ 2.0042	+47.9834	38	+ 1.8935	+47.9960	34	− 0.8050	+10.4852
39	+ 2.9086	− 7.9242	39	+ 2.9453	− 7.9154	35	0.0000	0.0000
42	+ 4.8818	+32.7970	42	+ 4.8140	+32.8086	36	+ 0.4790	+24.3084
45	+ 8.3714	+30.6040	45	+ 8.3078	+30.6244	38	+ 1.9332	+47.9950
48	+10.3031	+51.9568	48	+10.1816	+51.9801	39	+ 2.9464	− 7.9199
49	+11.3010	+ 5.9155	49	+11.2946	+ 5.9346	40	+ 3.0012	−13.8622
51	+12.6459	− 3.7267	51	+12.6628	− 3.7050	42	+ 4.8420	+32.8034
52	+13.4830	−34.3415	52	+13.5774	−34.3133	45	+ 8.3362	+30.6148
56	+20.4300	−57.2463	56	+20.5768	−57.2070	48	+10.2359	+51.9754
57	+20.7315	− 3.5814	57	+20.7500	− 3.5447	49	+11.3055	+ 5.9295
59	+25.1238	+19.8158	59	+25.0867	+19.8629	50	+12.5120	−27.4396
60	+26.2372	−45.3074	60	+26.3549	−45.2594	51	+12.6618	− 3.7143
63	+28.5880	+ 7.6812	63	+28.5813	+ 7.7303	52	+13.5582	−34.3316
64	+29.2121	−39.1878	64	+29.3207	−39.1380	56	+20.5375	−57.2278
68	+32.4567	− 1.3724	68	+32.4724	− 1.3120	57	+20.7559	− 3.5588
71	+35.5707	+ 1.0313	71	+35.5791	+ 1.0927	59	+25.1078	+19.8443
73	+35.6082	+27.7402	73	+35.5475	+27.8004	60	+26.3257	−45.2806
77	+39.3402	+30.3516	75	+38.3726	+ 8.1954	63	+28.5858	+ 7.7129
83	+48.8794	+14.8796	83	+48.8554	+14.9654	64	+29.2962	−39.1606
			86	+57.1981	−42.5731	68	+32.4784	− 1.3358
						71	+35.5924	+ 1.0672
						73	+35.5735	+27.7755
						75	+38.3834	+ 8.1703
						77	+39.3114	+30.4032
						83	+48.8704	+14.9351
						86	+57.2017	−42.6342

TABLE III.—η CYGNI REFRACTION COEFFICIENTS.

Plate.	M_x	N_x	M_y	N_y
1	+0.000344	+0.000067	—0.000127	+0.000285
2	+ .000366	+ .000071	— .000146	+ .000293
3	+ .000328	+ .000061	— .000103	+ .000286
4	+ .000331	— .000059	+ .000096	+ .000295
5	+ .000360	— .000070	+ .000131	+ .000300
6	+ .000397	— .000077	+ .000170	+ .000307
10	+ .000573	+ .000050	— .000348	+ .000352
12	+ .000661	— .000042	+ .000415	+ .000397
13	+ .000580	— .000063	+ .000339	+ .000366

TABLE IV.—η CYGNI PLATE CONSTANTS.

Plate.	p	r	Probable Error of p or r.	k	c	Probable Error of k or c.	Probable Error of One Equation.
				″	″	″	″
1	—0.000034	—0.000486	±0.000008	+0″.500	+0″.322	±0″.016	±0″.0879
2	— .000047	— .000800	.000008	+ .489	+ .360	.016	.0881
3	— .000026	— .000338	.000007	+ .545	+ .283	.014	.0755
4	— .000021	+ .000056	.000007	— .590	— .070	.014	.0804
5	— .000019	+ .000262	.000006	— .408	— .147	.013	.0710
6	+ .000008	+ .000137	.000006	— .438	— .206	.013	.0729
10	+ .000095	— .001034	.000009	+ .422	— .127	.019	.1043
12	+ .000047	+ .001471	.000007	— .185	— .260	.015	.0846
13	— .000004	+ .000732	.000008	— .342	— .154	.016	.0890

TABLE V.—η CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.

Star.	X_m	1	2	3	4	5	6	10	12	13
	″	″	″	″	″	″	″	″	″	″
1	—2984.47			—.05	+.11	—.11	+.05			
2	—2808.35			—.15	+.08	+.07				
3	—2596.06			—.34	+.06	+.27				
4	—2545.71			—.02	+.03	.00				
5	—2300.18	+.03	—.01	+.04	—.10	+.04	+.02	—.13	+.14	—.04
6	—2240.16		+.12	—.29	+.05	+.11				
7	—2177.25	+.10	—.07	+.08	—.07	.00	+.04	—.17	+.28	—.16
8	—2083.67		—.09	+.06	—.03	+.07				
9	—2008.78			—.06	+.18	—.13				
10	—1960.18	+.06	—.13	—.03	+.09	—.09	+.07	+.08	—.08	+.03
11	—1911.17			—.22	—.05	+.30	—.03			
12	—1892.15	+.04	+.05	—.06	—.17	+.10	—.11	+.10	+.06	—.03
13	—1726.10	—.02	—.11	+.06	—.08	+.07	—.09	—.05	+.18	+.04
14	—1704.10		+.11	—.21	+.11	—.03				
15	—1684.72	—.05	—.08	+.03	+.09	+.15	+.09	+.01	—.11	—.08
16	—1645.77	—.19	—.20	—.13	+.03	+.04	+.20	—.13	+.09	+.24
17	—1594.77			—.04	+.07	—.04				
18	—1474.84	—.06	—.17	+.12	—.10	+.01	+.17			
19	—1276.46			+.05	+.21	—.25				
20	—1228.42		—.22	+.15	+.04	+.02				
21	—1105.08	—.07	+.10	—.18	+.09	—.03	+.07	+.04	—.16	+.18
22	—1031.89		+.05	—.12	+.33	—.27				
23	—1016.94		—.19	—.05	+.07	+.18				
24	— 986.93		.00	—.11	—.01	+.10	+.07			—.03
25	— 974.96	—.14	+.22	—.10	.00	—.08	.00	+.19	—.02	—.08
26	— 945.54		+.50	—.34	+.04	—.19				
27	— 498.24		—.36	+.02	+.25	+.07				
28	— 493.86		+.05	+.08	+.02	—.17				
29	— 395.34	—.21	—.09	—.12	+.07	+.16	+.03	+.09	+.06	.00
30	— 209.94	+.17	+.02	.00	—.01	.00	—.05	+.07	—.07	—.12
31	— 150.19	+.07	+.03	+.09	+.07	+.15	+.16	—.65	—.09	+.16
32	— 89.05	—.03	+.01	—.07	+.10	.01	+.08			—.09
33	— 51.68			—.04	+.01	+.03				
34	— 42.67	+.03	—.16	—.07	+.20	+.10	—.08	—.20	+.05	+.12
35	0.00	+.50	+.49	+.54	—.59	—.41	—.44	+.42	—.18	—.34
36	+ 25.58	—.09	—.08	—.19	—.07	+.08	+.07			+.27
37	+ 57.30			+.05	—.02	—.04				
38	+ 103.80	+.11	—.05	+.06	+.10	+.02	—.07	+.16	—.17	—.17
39	+ 155.08	—.11	+.06	—.09	+.13	+.08	+.16	—.36	—.04	+.17
40	+ 157.88	+.20	—.27	—.10	+.10	+.04	—.04			+.05
41	+ 160.54			—.18	—.28	+.45				
42	+ 256.96	+.05	—.02	—.09	—.06	—.03	+.04	+.04	+.03	.00
43	+ 280.50			+.10	—.20	+.10				
44	+ 375.61			+.11	—.02		—.09			
45	+ 441.70	—.04	—.08	+.07	+.11	—.07	—.01	+.02	—.03	+.03
46	+ 502.63			+.01	+.08	—.09				
47	+ 513.72	+.07	+.24	—.01	+.02	—.21	—.09			
48	+ 542.66	—.22	—.02	+.04	+.03	—.02	—.04	+.14	—.24	+.32
49	+ 597.95	—.05	+.09	—.20	+.01	—.05	+.25	+.05	—.12	—.02

TABLE V.—η CYGNI MEAN Y AND RESIDUALS FOR EACH PLATE.

Star.	Y_m	1	2	3	4	5	6	10	12	13
	″	″	″	″	″	″	″	″	″	″
1	—1095.76			—.05	+.11	.00	—.07			
2	+1949.58			—.01	—.18	+.20				
3	+ 239.14			+.23	—.17	—.05				
4	—1881.42			—.02	.00	+.02				
5	+ 155.17	+.01	—.02	—.04	—.03	+.06	—.01	—.11	+.08	+.10
6	— 580.58		—.35	+.17	+.11	+.06				
7	— 112.26	.00	+.13	+.01	—.03	+.06	+.02	—.17	+.09	—.14
8	— 427.82		—.13	—.04	—.03	+.22				
9	+ 374.28			—.10	+.04	+.06				
10	+2783.53	—.08	+.15	—.11	—.05	+.13	+.02	—.07	+.01	—.01
11	—1798.16			+.06	—.03	+.09	—.11			
12	—1770.83	+.05	+.21	+.08	—.26	—.19	—.13	+.29	—.01	—.03
13	—2227.39	—.03	—.16	+.04	—.10	—.16	+.03	+.13	+.22	+.02
14	+ 124.63		—.31	+.28	—.02	+.06				
15	—2460.66	—.25	—.02	—.15	+.10	+.12	+.12	+.06	+.10	—.06
16	—1924.12	—.16	—.01	—.01	—.05	+.02	—.04	—.07	+.17	+.11
17	+2696.26			—.08	+.12	—.05				
18	—2099.62	+.14	—.12	—.14	+.11	+.08	—.09			
19	+1175.61			+.20	.00	—.21				
20	—1066.59		—.17	+.12	+.13	—.09				
21	— 265.32	.00	—.08	+.04	+.09	+.09	—.02	—.06	—.07	+.01
22	+2656.66		+.28	.00	—.12	—.15				
23	— 525.13		—.13	—.04	+.16	+.02				
24	+1621.17		—.08	—.07	+.07	+.05	+.24			—.22
25	— 649.44	—.10	+.04	.00	+.01	+.07	—.06	+.07	—.06	+.04
26	+1455.10		+.08	—.08	—.01	—.01				
27	— 517.64		—.09	—.03	+.08	+.03				
28	—1340.46		+.04	+.18	—.14	—.08				
29	— 337.58	—.01	—.08	—.01	+.08	+.02	+.08	—.15	.00	+.09
30	+2666.94	+.13	—.10	.00	—.08	—.03	+.12	+.08	—.02	—.09
31	+1624.17	—.02	—.05	—.09	—.01	—.02	+.08	—.04	+.03	+.10
32	+1049.77	+.04	—.04	+.03	+.09	+.10	—.05			—.16
33	—3082.91			+.09	+.16	—.25				
34	+ 554.33	+.04	—.06	+.06	—.02	+.13	+.04	—.08	—.16	+.08
35	0.00	+.32	+.36	+.28	—.07	—.15	—.21	—.13	—.26	—.15
36	+1285.55	+.14	—.05	.00	—.02	+.05	—.07			—.05
37	+2920.70			—.40	+.33	+.06				
38	+2538.12	.00	—.12	—.01	—.06	—.04	+.07	—.17	+.19	+.10
39	— 419.04	+.05	—.03	+.06	+.14	.00	+.04	—.11	—.08	—.06
40	— 733.31	+.04	+.05	+.02	+.02	—.11	+.03			—.06
41	+ 148.27			—.07	—.17	+.23				
42	+1734.69	—.04	—.09	—.04	—.04	—.03	—.04	+.12	+.14	.00
43	+2207.49			+.13	—.04	—.10				
44	+3426.75			+.04	—.12		+.08			
45	+1618.85	—.05	—.08	—.05	+.02	—.09	—.08	+.08	+.25	+.01
46	— 555.50			+.05	+.05	—.10				
47	+2966.95	—.07	—.40	—.11	+.18	+.30	+.11			
48	+2748.51	—.18	+.02	—.06	—.02	+.12	+.08	—.08	+.07	+.06
49	+ 313.08	+.02	—.06	—.14	+.01	—.03	+.04	+.09	—.08	+.13

TABLE V.—η CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.—*Continued.*

Star.	X_m	1	2	3	4	5	6	10	12	13
50	+ 660″.42	−″.14	+″.11	+″.14	−″.16	−″.07	−″.07	″	″	+″.16
51	+ 669.59	−.11	+.20	.00	−.12	+.13	+.17	+.06	−.11	−.25
52	+ 715.63	+.15	+.13	+.06	−.12	−.08	−.05	−.09	−.07	+.04
53	+ 926.94	−.02	−.05	−.08	+.22	−.05				
54	+ 965.26			+.16	−.21	+.05				
55	+1059.90		−.21	+.13	+.06	+.03				
56	+1084.08	+.14		−.04	−.06	−.26	−.05	+.17	+.08	+.01
57	+1097.35	−.10	−.12	−.03	+.22	−.10	−.12	+.06	+.03	+.18
58	+1239.42		+.20	.00	−.05	−.17				
59	+1328.62	+.07	+.04	.00	+.11	.00	−.08	−.05	−.03	−.05
60	+1390.75	+.08	+.15	−.05	.00	−.15	−.08	+.12	.00	−.05
61	+1508.39			+.08	+.02	−.09				
62	+1511.22	+.14	−.30	−.13	+.15	+.13				
63	+1512.43	−.03	−.05	−.05	+.08	+.14	+.06	+.05	+.13	−.30
64	+1548.01	−.07	−.08	−.01	+.01	−.01	+.04	−.08	+.13	+.05
65	+1595.34	−.32	−.31	−.04	+.13	+.38	+.14			
66	+1625.24		−.22	−.06	−.04	+.50	−.16			
67	+1705.20			−.12	+.23	−.12				
68	+1717.69	−.06	−.07	+.06	+.03	−.05	+.07	−.06	+.05	+.04
69	+1707.02		−.20	+.12	+.18	+.02	−.14			
70	+1817.59			−.07	+.05	+.03				
71	+1882.25	−.05	−.16	+.01	−.01	+.03	−.14	−.01	+.05	+.30
72	+1893.32		−.23	+.04	+.08	+.11				
73	+1882.68	+.22	−.02	+.12	−.03	−.19	−.06	+.16	−.03	−.18
74	+1904.58	+.20	+.56	−.36	−.14	−.25				
75	+2030.44	+.29	−.14	+.10	−.15	−.05	−.21		+.19	+.01
76	+2076.05	+.30	−.12	−.23	.00	+.02	+.01			
77	+2080.11	−.07	−.11	+.03	−.12	−.06	+.04	+.04		+.22
78	+2206.82	−.29	−.33	−.11	+.50	+.10	+.15			
79	+3221.07	+.08	+.01		+.06	−.15				
80	+2306.73	−.08	−.33	−.13	+.13	+.32	+.11			
81	+2319.77		−.08	+.11			−.03			
82	+2485.52			−.26		+.23	+.03			
83	+2585.50	−.18	−.10	−.05	−.12	+.15	−.04	+.12	+.26	−.04
84	+2666.47	.00	−.27	+.07	−.02	+.19	+.04			
85	+2951.64		+.22	+.09	+.08		−.38			
86	+3023.50			+.07					−.71	+.64

TABLE V.—η CYGNI MEAN Y AND RESIDUALS FOR EACH PLATE.—*Continued.*

Star.	Y_m	1	2	3	4	5	6	10	12	13
	″	″	″	″	″	″	″	″	″	″
50	−1451.70	+.10	−.14	.00	+.02	+.03	−.06			+.03
51	− 196.85	+.02	+.06	−.08	−.02	+.01	.00	+.07	−.08	−.01
52	−1816.06	−.04	+.09	−.12	+.09	+.09	.00	−.02	+.10	−.14
53	− 652.96	+.18	−.06	−.07	+.02	−.06				
54	−1861.71			−.20	+.16	+.05				
55	+ 436.08		−.19	+.04	+.07	+.10				
56	−3027.31	−.01		−.13	+.11	+.09	−.06	−.04	+.03	.00
57	− 188.74	+.23	−.02	+.03	+.15	−.10	+.02	−.07	−.17	−.07
58	−1307.92		+.08	−.20	+.15	−.04				
59	+1048.89	−.05	−.06	+.01	+.02	+.04	−.04	+.03	+.06	−.02
60	−2395.65	+.02	−.15	+.04	+.03	−.02	−.06	+.01	.00	+.09
61	+ 726.26			+.12	−.10	−.01				
62	+ 462.67	+.09	−.08	−.05	−.06	+.11				
63	+ 407.14	−.08	−.08	−.01	+.02	−.02	+.15	+.05	−.11	+.04
64	−2071.95	+.09	+.04	.00	−.04	−.07	−.03	+.10	−.10	+.02
65	+2857.48	+.04	−.39	−.16	+.09	+.13	+.29			
66	+1925.33		−.30	+.05	+.11	+.25	−.10			
67	−1846.04			+.16	+.16	−.33				
68	− 71.45	+.05	+.10	−.05	+.10	.00	−.05	−.10	−.03	−.03
69	+1888.85		−.13	+.16	+.05	+.01	−.09			
70	+1917.37			−.21	+.26	−.06				
71	+ 55.58	.00	−.11	+.05	+.05	.00	−.08	+.13	−.03	−.03
72	− 927.35		−.20	+.23	+.04	−.07				
73	+1468.34	+.06	+.19	+.16	−.07	−.02	−.08	+.10	−.13	−.20
74	−1538.23	+.26	−.21	−.12	+.20	−.15				
75	+ 431.06	+.06	−.17	+.01	+.02	−.10	+.05		+.02	+.11
76	+1608.73	+.11	−.05	−.06	−.11	+.13	−.04			
77	+1606.76	+.05	−.06	−.05	−.01	−.07	−.04	−.05		+.27
78	+2779.38	+.39	−.19	−.36	+.31	−.03	−.09			
79	−2150.74	−.23	+.06		+.07	+.08				
80	+2386.17	−.12	−.43	−.05	−.04	+.40	+.24			
81	+2903.26		−.37	+.17			+.19			
82	+2612.46			−.29		+.13	+.15			
83	+ 788.68	−.04	−.02	+.09	+.03	.00	+.02	+.01	−.11	+.06
84	+ 741.16	+.10	+.05	.00	+.04	−.08	−.08			
85	+ 963.70		−.39	+.02	+.16		+.23			
86	−2255.92			−.31					+.63	−.31

TABLE VI.—η CYGNI CONCORDANCE WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.
2	8797	21	7763	43	8859	64	7822
4	7738	22	8829	45	7801	68	7829
5	7740	23	7768	47	8865	73	7832
7	7742	25	7769	48	8866	74	7833
10	8816	29	7778	51	7804	77	7839
12	7745	30	8843	52	7805	79	7843
13	7748	31	8845	56	7809	81	8911
15	7750	35	7786	59	7811	84	7853
16	7754	38	8855	60	7812	85	7857
18	7755	42	8857	63	7818	86	7858

TABLE VII.—η CYGNI COMPARISON WITH ASTRONOMISCHE GESELLSCHAFT CATALOG

$p = +\,0.000393 \pm 0.000024$ $\qquad k = -\,0''.466 \pm 0''.061$

$r = +\,0.000194 \pm 0.000024$ $\qquad c = +\,0''.313 \pm 0''.061$

Probable error of a single equation = ± 0.3841

RESIDUALS.

Star.	v_x	v_y	Star.	v_x	v_y
2	−1″.49	−0″.68	43	−0″.78	−0″.30
4	−0.03	+0.50	45	+0.70	+0.35
5	+0.35	+0.47	47	+0.11	−0.43
7	+0.18	−0.04	48	+0.06	−0.37
10	+0.21	+0.19	51	−0.19	+0.50
12	+0.51	+0.37	52	−0.13	−0.10
13	+0.42	+0.56	56	+0.17	−0.10
15	+0.12	+0.67	59	+0.80	+0.55
16	+0.44	+0.93	60	−0.50	−0.42
18	−0.17	+0.24	63	+0.63	+0.16
21	+0.10	+0.35	64	−0.35	+0.17
22	−0.99	−0.26	68	+0.26	+0.14
23	−0.20	+0.44	73	−0.27	−0.21
25	+0.69	+0.41	74	−0.44	−0.17
29	−0.22	+0.11	77	−0.21	−0.13
30	−0.50	−0.58	79	+1.12	−1.10
31	−0.13	+0.78	81	−0.57	−0.17
35	−0.47	+0.31	84	−0.01	−0.01
38	−0.73	+0.06	85	+0.16	−1.29
42	−0.49	−0.62	86	+1.83	−1.29

TABLE VIII.—η CYGNI FINAL COÖRDINATES.

Star.	*X*	*Y*	Star.	*X*	*Y*
1	−2986″.32	−1095″.30	44	+ 375″.95	+3428″.34
2	−2809.54	+1951.20	45	+ 441.71	+1619.71
3	−2597.50	+ 240.04	46	+ 502.25	− 555.51
4	−2547.54	−1881.36	47	+ 514.03	+2968.33
5	−2301.52	+ 155.99	48	+ 542.93	+2749.79
6	−2241.62	− 580.07	49	+ 597.77	+ 313.39
7	−2178.60	− 111.57	50	+ 659.93	−1452.09
8	−2085.04	− 427.28	51	+ 669.34	− 196.75
9	−2009.97	+ 375.13	52	+ 715.09	−1816.60
10	−1960.88	+2785.31	53	+ 926.70	− 653.09
11	− 1912.74	−1798.19	54	+ 964.81	−1862.32
12	−1893.70	−1770.85	55	+1059.93	+ 436.35
13	−1727.68	−2227.63	56	+1083.45	−3028.40
14	−1705.22	+ 125.32	57	+1097.27	− 188.71
15	−1686.33	−2460.99	58	+1239.19	−1308.36
16	−1647.26	−1924.25	59	+1328.87	+1049.35
17	−1595.35	+2697.94	60	+1390.37	−2396.55
18	−1476.30	−2099.85	61	+1508.65	+ 726.57
19	−1277.20	+1176.63	62	+1511.43	+ 462.87
20	−1229.58	−1066.46	63	+1512.63	+ 407.32
21	−1106.03	− 264.90	64	+1547.75	−2072.75
22	−1032.25	+2658.21	65	+1596.05	+2858.60
23	−1017.91	− 524.83	66	+1625.78	+1926.08
24	− 987.47	+1622.31	67	+1705.04	−1846.79
25	− 975.94	− 649.20	68	+1717.89	− 71.50
26	− 946.10	+1456.16	69	+1707.59	+1889.57
27	− 499.01	− 517.43	70	+1818.20	+1918.08
28	− 494.78	−1340.58	71	+1882.53	+ 55.54
29	− 396.04	− 337.32	72	+1893.41	− 927.77
30	− 209.97	+2668.34	73	+1883.23	+1468.86
31	− 150.40	+1625.15	74	+1904.56	−1538.89
32	− 89.35	+1050.51	75	+2030.85	+ 431.15
33	− 52.77	−3083.80	76	+2076.71	+1609.27
34	− 43.05	+ 554.87	77	+2080.77	+1607.30
35	− 0.47	+ 0.31	78	+2207.76	+2780.35
36	+ 25.37	+1286.37	79	+2321.09	−2151.73
37	+ 57.42	+2922.15	80	+2307.63	+2386.97
38	+ 103.86	+2539.41	81	+2320.77	+2904.26
39	+ 154.59	− 418.92	82	+2486.54	+2613.32
40	+ 157.33	− 733.32	83	+2586.20	+ 788.80
41	+ 160.16	+ 148.61	84	+2667.19	+ 741.24
42	+ 256.93	+1735.63	85	+2952.52	+ 963.82
43	+ 280.57	+2208.62	86	+3023.78	−2257.09

Table IX.—η Cygni Diameters of Star Images.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r
1	0.196	30	0.185	59	0.153
2	0.190	31	0.155	60	0.225
3	0.143	32	0.125	61	0.119
4	0.168	33	0.174	62	0.113
5	0.142	34	0.118	63	0.112
6	0.143	35	0.360	64	0.204
7	0.132	36	0.134	65	0.171
8	0.115	37	0.179	66	0.141
9	0.127	38	0.183	67	0.151
10	0.266	39	0.123	68	0.160
11	0.130	40	0.116	69	0.124
12	0.238	41	0.153	70	0.142
13	0.152	42	0.157	71	0.116
14	0.116	43	0.177	72	0.133
15	0.144	44	0.185	73	0.238
16	0.131	45	0.171	74	0.139
17	0.177	46	0.120	75	0.113
18	0.149	47	0.208	76	0.154
19	0.115	48	0.167	77	0.152
20	0.130	49	0.113	78	0.170
21	0.120	50	0.114	79	0.193
22	0.158	51	0.197	80	0.169
23	0.108	52	0.134	81	0.212
24	0.127	53	0.134	82	0.133
25	0.153	54	0.171	83	0.161
26	0.118	55	0.122	84	0.160
27	0.108	56	0.232	85	0.141
28	0.130	57	0.125	86	0.161
29	0.111	58	0.148		

TABLE X.—η CYGNI FINAL CATALOG.

No.	Magnitude.	No. of Plates.	Right Ascension 1875.0 In Time.	Right Ascension 1875.0 In Arc.	Precession. In Time.	Precession. In Arc.	Secular Variation. In Time.	Secular Variation. In Arc.	Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	8.0	4	19 47 35.661	296 53 54.91	+2.2545	+33.8177	+0.0013	+0.0201	34 26 37.84	+9.0728	+0.2893	1875.69
2	8.1	3	47 47.605	296 56 54.08	2.2287	33.4307	0.0013	0.0200	35 17 25.56	9.0883	0.2858	75.67
3	8.8	3	48 6.141	297 1 32.12	2.2440	33.6602	0.0013	0.0202	34 48 56.63	9.1124	0.2876	75.67
4	8.4	3	48 11.664	297 2 54.96	2.2622	33.9333	0.0014	0.0203	34 13 35.95	9.1196	0.2899	75.67
5	8.8	9	48 30.224	297 7 33.36	2.2455	33.6818	0.0014	0.0203	34 47 35.03	9.1436	0.2875	76.02
6	8.8	4	48 35.536	297 8 53.04	+2.2519	+33.7785	+0.0014	+0.0203	34 35 19.49	+9.1506	+0.2883	75.64
7	9.0	9	48 40.361	297 10 5.41	2.2480	33.7207	0.0014	0.0203	34 43 8.42	9.1568	0.2877	76.02
8	9.3	4	48 48.127	297 12 1.91	2.2510	33.7646	0.0014	0.0204	34 37 53.40	9.1669	0.2880	75.64
9	9.0	3	48 53.769	297 13 26.53	2.2443	33.6644	0.0014	0.0203	34 51 16.27	9.1743	0.2871	75.67
10	7.3	9	48 56.453	297 14 6.79	2.2236	33.3537	0.0013	0.0201	35 31 26.45	9.1777	0.2844	76.02
11	9.0	4	49 2.796	297 15 41.94	+2.2630	+33.9453	+0.0014	+0.0204	34 15 3.78	+9.1859	+0.2894	75.69
12	7.5	9	49 4.317	297 16 4.76	2.2628	33.9426	0.0014	0.0204	34 15 31.23	9.1879	0.2894	76.02
13	8.6	9	49 17.919	297 19 28.79	2.2671	34.0063	0.0014	0.0205	34 7 55.51	9.2056	0.2898	76.02
14	9.3	4	49 18.641	297 19 39.61	2.2472	33.7078	0.0014	0.0204	34 47 8.38	9.2065	0.2872	75.64
15	8.7	9	49 21.355	297 20 20.33	2.2692	34.0373	0.0014	0.0205	34 4 2.43	9.2100	0.2900	76.02
16	9.0	9	49 24.261	297 21 3.92	+2.2647	+33.9709	+0.0014	+0.0205	34 12 59.29	+9.2137	+0.2894	76.02
17	8.2	3	49 26.428	297 21 36.42	2.2253	33.3791	0.0014	0.0203	35 30 1.35	9.2165	0.2843	75.67
18	8.7	6	49 38.112	297 24 31.68	2.2666	33.9992	0.0014	0.0206	34 10 4.60	9.2317	0.2895	75.64
19	9.3	3	49 53.014	297 28 15.21	2.2392	33.5885	0.0014	0.0205	35 4 41.80	9.2509	0.2858	75.67
20	9.0	4	49 57.647	297 29 24.70	2.2585	33.8774	0.0014	0.0206	34 27 19.00	9.2570	0.2882	75.64
21	9.2	9	50 7.394	297 31 50.91	+2.2520	+33 7799	+0.0014	+0.0206	34 40 41.01	+9.2696	+0.2872	76.02
22	8.5	4	50 12.545	297 33 8.17	2.2271	33.4060	0.0014	0.0204	35 29 24.18	9.2762	0.2840	75.64
23	9.4	4	50 14.609	297 33 39.14	2.2544	33.8164	0.0014	0.0207	34 36 21.40	9.2789	0.2875	75.64
24	9.0	6	50 16.494	297 34 7.41	2.2361	33.5420	0.0014	0.0206	35 12 8.57	9.2813	0.2851	75.87
25	8.6	9	50 18.042	297 34 30.63	2.2556	33.8337	0.0014	0.0207	34 34 17.17	9.2834	0.2876	76.02

TABLE X.—η CYGNI FINAL CATALOG.—*Continued.*

No.	Magnitude.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
26	9.2	4	19 50 19.913	297 34 58.69	+2.2377	+33.5650	+0.0014	+0.0206	35 9 22.57	+9.2858	+0.2852	1875.64
27	9.4	4	50 56.637	297 44 9.55	2.2557	33.8349	0.0014	0.0208	34 36 30.11	9.3332	0.2871	75.64
28	9.0	4	50 57.090	297 44 16.35	2.2626	33.9393	0.0014	0.0209	34 22 46.99	9.3338	0.2880	75.64
29	9.4	9	51 4.958	297 46 14.37	2.2544	33.8158	0.0014	0.0209	34 39 30.38	9.3439	0.2869	76.02
30	8.1	9	51 19.865	297 49 57.97	2.2291	33.4370	0.0014	0.0207	35 29 36.08	9.3632	0.2834	76.02
31	8.6	9	51 24.785	297 51 11.78	+2.2383	+33.5742	+0.0014	+0.0208	35 12 13.04	+9.3695	+0.2846	76.02
32	9.1	7	51 29.781	297 52 26.71	2.2434	33.6504	0.0014	0.0209	35 2 38.45	9.3760	0.2852	75.83
33	8.3	3	51 32.818	297 53 12.27	2.2783	34.1746	0.0014	0.0210	33 53 44.38	9.3798	0.2896	75.67
34	9.2	9	51 33.557	297 53 23.35	2.2477	33.7155	0.0014	0.0209	34 54 22.83	9.3808	0.2857	76.02
35	6.6	9	51 37.018	297 54 15.27	2.2525	33.7880	0.0014	0.0210	34 45 8.27	9.3852	0.2863	76.02
36	8.9	7	51 39.123	297 54 46.85	+2.2416	+33.6246	+0.0014	+0.0209	35 6 34.31	+9.3880	+0.2848	75.83
37	8.2	3	51 41.761	297 55 26.42	2.2276	33.4147	0.0014	0.0208	35 33 49.91	9.3914	0.2830	75.67
38	8.2	9	51 45.556	297 56 23.34	2.2311	33.4662	0.0014	0.0208	35 27 27.22	9.3963	0.2834	76.02
39	9.1	9	51 49.582	297 57 23.73	2.2565	33.8472	0.0014	0.0210	34 38 9.00	9.4015	0.2866	76.02
40	9.3	7	51 49.791	297 57 26.86	2.2591	33.8871	0.0014	0.0211	34 32 54.60	9.4018	0.2870	75.83
41	8.6	3	51 50.058	297 57 30.87	+2.2517	+33.7752	+0.0014	+0.0210	34 47 36.53	+9.4021	+0.2860	75.67
42	8.5	9	51 58.026	297 59 30.39	2.2384	33.5760	0.0014	0.0210	35 14 3.44	9.4123	0.2842	76.02
43	8.2	3	51 59.992	297 59 59.88	2.2344	33.5160	0.0014	0.0209	35 21 56.36	9.4149	0.2837	75.67
44	8.1	3	52 7.916	298 1 58.74	2.2241	33.3618	0.0014	0.0209	35 42 15.74	9.4251	0.2822	75.67
45	8.3	9	52 13.093	298 3 16.39	2.2399	33.5982	0.0014	0.0210	35 12 7.30	9.4317	0.2842	76.02
46	9.2	3	52 17.733	298 4 25.99	+2.2585	+33.8779	+0.0014	+0.0212	34 35 52.03	+9.4377	+0.2866	75.67
47	7.9	6	52 19.185	298 4 47.77	2.2285	33.4271	0.0014	0.0210	35 34 35.63	9.4396	0.2827	75.64
48	8.4	9	52 21.521	298 5 22.81	2.2304	33.4566	0.0014	0.0210	35 30 57.08	9.4426	0.2829	76.02
49	9.3	9	52 25.610	298 6 24.15	2.2514	33.7713	0.0014	0.0212	34 50 20.75	9.4478	0.2856	76.02
50	9.3	7	52 30.342	298 7 35.13	2.2665	33.9970	0.0014	0.0213	34 20 55.17	9.4539	0.2874	75.83

TABLE X.—η CYGNI FINAL CATALOG.—*Continued.*

No.	Magnitude.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
51	8.0	9	19 52 31.330	298 7 49.95	+2.2559	+33.8390	+0.0014	+0.0212	34 41 50.46	+9.4552	+0.2861	1876.02
52	8.9	9	52 34.726	298 8 40.89	2.2697	34.0448	0.0014	0.0213	34 14 50.56	9.4596	0.2878	76.02
53	8.9	5	52 52.083	298 13 1.24	2.2604	33.9067	0.0014	0.0213	34 34 13.44	9.4819	0.2864	75.63
54	8.3	3	52 54.853	298 13 42.79	2.2707	34.0602	0.0014	0.0214	34 14 4.16	9.4855	0.2877	75.67
55	9.1	4	53 3.184	298 15 47.76	2.2516	33.7739	0.0014	0.0213	34 52 22.41	9.4962	0.2851	75.64
56	7.6	8	53 4.079	298 16 1.19	+2.2807	+34.2100	+0.0014	+0.0214	33 54 37.87	+9.4973	+0.2889	76.08
57	9.1	9	53 6.031	298 16 30.46	2.2570	33.8546	0.0014	0.0214	34 41 57.23	9.4998	0.2858	76.02
58	8.7	4	53 17.162	298 19 17.43	2.2667	34.0012	0.0014	0.0215	34 23 17.07	9.5141	0.2869	75.64
59	8.6	9	53 25.260	298 21 18.90	2.2471	33.7066	0.0014	0.0214	35 2 34.30	9.5245	0.2843	76.02
60	7.7	9	53 28.966	298 22 14.49	2.2762	34.1431	0.0014	0.0215	34 5 8.35	9.5292	0.2880	76.02
61	9.2	3	53 39.765	298 24 56.47	+2.2503	+33.7548	+0.0014	+0.0215	34 57 10.67	+9.5431	+0.2845	75.67
62	9.3	5	53 39.881	298 24 58.22	2.2526	33.7885	0.0014	0.0215	34 52 46.97	9.5432	0.2848	75.63
63	9.3	9	53 39.956	298 24 59.34	2.2530	33.7956	0.0014	0.0215	34 51 51.42	9.5433	0.2849	76.02
64	7.9	9	53 41.767	298 25 26.51	2.2739	34.1089	0.0014	0.0216	34 10 31.34	9.5457	0.2875	76.02
65	8.3	6	53 47.813	298 26 57.19	2.2324	33.4856	0.0014	0.0214	35 32 41.97	9.5534	0.2821	75.64
66	8.8	5	53 49.828	298 27 27.42	+2.2404	+33.6066	+0.0014	+0.0214	35 17 9.45	+9.5560	+0.2832	75.66
67	8.6	3	53 54.544	298 28 38.16	2.2725	34.0868	0.0014	0.0216	34 14 16.42	9.5620	0.2872	75.67
68	8.5	9	53 56.407	298 29 6.11	2.2576	33.8643	0.0014	0.0216	34 43 51.50	9.5644	0.2853	76.02
69	9.1	5	53 56.491	298 29 7.37	2.2410	33.6147	0.0014	0.0215	35 16 32.48	9.5645	0.2831	75.66
70	8.8	3	54 5.537	298 31 23.05	2.2410	33.6155	0.0014	0.0215	35 17 0.32	9.5762	0.2830	75.67
71	9.3	9	54 9.827	298 32 27.40	+2.2570	+33.8548	+0.0014	+0.0216	34 45 57.54	+9.5816	+0.2850	76.02
72	8.9	4	54 10.203	298 32 33.04	2.2653	33.9791	0.0014	0.0217	34 29 34.22	9.5821	0.2861	75.64
73	7.5	9	54 10.613	298 32 39.20	2.2450	33.6755	0.0014	0.0216	35 9 30.74	9.5826	0.2835	76.02
74	8.8	5	54 10.789	298 32 41.84	2.2704	34.0560	0.0014	0.0217	34 19 23.10	9.5829	0.2867	75.63
75	9.3	8	54 22.071	298 35 31.06	2.2542	33.8133	0.0014	0.0217	34 52 12.14	9.5973	0.2845	75.96

TABLE X.—η CYGNI FINAL CATALOG. *Concluded.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
76	8.6	6	19 54 26.469	298 36 37.03	+2.2444	+33.6655	+0.0014	+0.0216	35 11 49.82	+9.6030	+0.2832	1875.64
77	8.6	8	54 26.799	298 36 41.98	2.2444	33.6659	0.0014	0.0216	35 11 47.83	9.6034	0.2832	75.91
78	8.3	6	54 37.875	298 39 28.12	2.2347	33.5211	0.0014	0.0216	35 31 19.71	9.6175	0.2818	75.64
79	8.0	4	54 44.024	298 41 0.36	2.2766	34.1488	0.0015	0.0218	34 9 7.45	9.6254	0.2871	75.64
80	8.4	6	54 45.801	298 41 27.01	2.2384	33.5757	0.0014	0.0217	35 24 45.65	9.6277	0.2822	75.64
81	7.8	3	54 47.209	298 41 48.13	+2.2340	+33.5099	+0.0014	+0.0216	35 33 22.70	+9.6295	+0.2816	75.62
82	8.9	3	55 0.588	298 45 8.82	2.2370	33.5543	0.0014	0.0217	35 28 30.46	9.6466	0.2819	75.67
83	8.5	9	55 7.442	298 46 51.63	2.2527	33.7907	0.0015	0.0219	34 58 5.42	9.6554	0.2838	76.02
84	8.5	6	55 13.995	298 48 29.92	2.2533	33.8001	0.0015	0.0219	34 57 17.14	9.6638	0.2838	75.64
85	8.8	4	55 37.378	298 54 20.67	2.2522	33.7837	0.0015	0.0220	35 0 56.97	9.6936	0.2834	75.64
86	8.5	3	55 40.531	298 55 7.96	2.2793	34.1895	0.0015	0.0221	34 7 15.94	9.6976	0.2868	76.47

TABLE I.—PHOTOGRAPHS OF 27 CYGNI.

OBSERVATORY OF L. M. RUTHERFURD, NEW YORK.

Lat. 40° 43′ 48″.5. Long. $4^{h}\ 55^{m}\ 56^{s}.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Zen. Dist.
				Att.	Ext.	Tel.		
		h m s	in.					°
1	1874 Nov. 12	0 4 12	30.268	38°	35°	40°	7.85	47.0
2	1874 Nov. 14	23 55 28	30.600	32	30	32	7.9	45.4
3	1875 Oct. 20	23 18 22	30.032	54	53	55	7.75	38.5
4	1875 Oct. 20	23 54 38	30.032	54	53	55	7.75	45.2
5	1876 June 21	16 49 32	30.068	69	67	70	7.6	37.7
6	1876 June 21	17 18 22	30.068	69	67	70	7.6	32.2
7	1876 June 21	17 48 2	30.068	69	67	70	7.6	26.6
8	1876 June 21	18 16 18	30.068	69	67	70	7.6	21.3

TABLE II. — CORRECTED COÖRDINATES, 27 CYGNI.

PLATE 1.

Star.	*X*	*Y*
1	−40.4223	+3.9120
2	−39.9988	+3.2137
3	−36.6780	+30.4131
4	−35.2146	−28.1070
5	−33.5818	−9.0450
6	−31.6205	−2.1821
8	−28.9721	+19.3697
9	−28.0894	−17.8288
10	−26.2462	+23.4820
11	−25.3116	−27.1375
12	−21.0278	−9.4072
13	−17.2653	+11.7013
15	−13.3038	+7.0252
16	−11.3023	−24.6329
17	−10.5276	−25.6913
18	−9.0088	−5.7750
19	−8.3186	+36.3506
20	−7.4714	−18.9999
21	−7.0935	−24.6952
22	−6.6944	−21.3750
23	−6.4982	−13.3536
24	−6.3204	−13.4639
25	−6.2283	+22.7987
26	−6.2101	+19.5906
27	−6.0572	−2.2124
28	−5.9886	−12.8721
29	−5.7306	−15.2474
30	−5.4093	−15.0336
32	−3.7806	−40.8834
33	−2.1585	+18.4772
34	−0.6496	−18.5614
35	0.0000	0.0000
36	+0.1122	+6.6169
37	+0.6776	+23.2315
38	+0.6663	+50.6770
39	+1.4448	+16.4748
41	+2.2994	−16.8312
42	+2.3778	+10.9231
43	+3.5394	−43.2595
44	+6.2972	−46.4455
45	+7.1870	−5.6709
46	+8.0128	+27.7376
47	+8.2134	−21.8188
48	+10.2487	+56.9667
49	+10.7252	−43.3470
50	+11.4323	+25.1517
51	+11.6569	−28.2586
52	+12.3152	−27.5436
53	+13.2509	−12.1037
54	+13.4950	−18.4766
55	+14.3117	−5.2159
58	+15.8134	−25.1930
59	+16.1842	−10.5394
60	+20.1976	+20.7674
61	+21.0596	−22.4196
62	+21.1222	−8.4844
63	+22.8817	−6.3769
64	+23.1230	+9.0322
65	+24.6953	−17.0569
66	+27.0218	−36.2252
67	+28.4620	+6.9500
68	+30.5900	+46.2652
69	+31.6114	+35.2388
70	+32.8406	+10.5976
71	+34.0818	−32.6316
72	+33.9330	+10.4623
73	+34.3368	−40.2170
74	+35.4073	+3.5633
76	+38.3288	−38.6249
77	+38.4865	+3.7900
78	+38.7897	−34.5855
79	+38.8762	−34.6435
80	+41.8736	−39.6255
81	+41.8122	+34.2693
82	+42.2422	−17.6573
83	+41.9149	+33.7257
84	+44.6611	−16.3029
85	+46.5211	+33.1680
86	+49.0416	−33.8679
87	+52.2356	+13.4292
88	+52.8247	+12.4304

PLATE 2.

Star.	*X*	*Y*
1	−40.4224	+3.8498
2	−40.0011	+3.1600
3	−36.7024	+30.3653
4	−35.1862	−28.1486
5	−33.5685	−9.0923
6	−31.6151	−2.2239
7	−31.6264	−6.6450
8	−28.9895	+19.3276
9	−28.0658	−17.8678
10	−26.2714	+23.4434
11	−25.2806	−27.1686
12	−21.0146	−9.4380
13	−17.2693	+11.6776
14	−16.7758	−19.1867
15	−13.3115	+7.0036
16	−11.2757	−24.6464
17	−10.4956	−25.7051
18	−8.9974	−5.7834
19	−8.3552	+36.3303
20	−7.4533	−19.0067
21	−7.0710	−24.7037
22	−6.6720	−21.3809
23	−6.4880	−13.3628
24	−6.3069	−13.4754
25	−6.2486	+22.7957
26	−6.2350	+19.5852
27	−6.0487	−2.2151
28	−5.9777	−12.8762
29	−5.7148	−15.2506
30	−5.3935	−15.0368
31	−5.2718	−52.2130
32	−3.7354	−40.8851
33	−2.1771	+18.4754
34	−0.6211	−18.5585
35	0.0000	0.0000
36	+0.1103	+6.6178
37	+0.6496	+23.2402
38	+0.6163	+50.6798
39	+1.4286	+16.4771
40	+2.0820	−7.4177
41	+2.3177	−16.8236
42	+2.3720	+10.9240
43	+3.5868	−43.2523
44	+6.3538	−46.4393
45	+7.1986	−5.6665
46	+7.9805	+27.7508
47	+8.2362	−21.8062
48	+10.1899	+56.9845
50	+11.4070	+25.1740
51	+11.6888	−28.2417
52	+12.3487	−27.5219
53	+13.2636	−12.0818
54	+13.5132	−18.4544
55	+14.3183	−5.1878
58	+15.8365	−25.1721
59	+16.1933	−10.5138
60	+20.1726	+20.7992
61	+21.0846	−22.3807
62	+21.1337	−8.4470
63	+22.8980	−6.3455
64	+23.1173	+9.0653
65	+24.7195	−17.0162
66	+27.0577	−36.1837

TABLE II.—CORRECTED COÖRDINATES, 27 CYGNI.—*Continued.*

PLATE 2.

Star.	*X*	*Y*
67	+28.4525	+ 6.9955
68	+30.5398	+46.3166
69	+31.5764	+35.2923
70	+32.8290	+10.6546
71	+34.1156	−32.5780
72	+33.9246	+10.5140
73	+34.3734	−40.1639
74	+35.4050	+ 3.6182
75	+36.0107	−11.2270
76	+38.3711	−38.5693
77	+38.4830	+ 3.8456
78	+38.8168	−34.5252
79	+38.9122	−34.5843
80	+41.9206	−39.5524
81	+41.7846	+34.3346
82	+42.2618	−17.5878
83	+41.8804	+33.7904
84	+44.6876	−16.2353
85	+46.4842	+33.2503
86	+49.0857	−33.7918
87	+52.2273	+13.5151
88	+52.8143	+12.5115

PLATE 3.

Star.	*X*	*Y*
1	−40.4233	+ 3.8949
2	−39.9987	+ 3.2020
3	−36.6870	+30.4061
4	−35.2101	−28.1126
5	−33.5793	− 9.0580
6	−31.6156	− 2.1882
7	−31.6284	− 6.6052
8	−28.9824	+19.3611
9	−28.0826	−17.8389
10	−26.2554	+23.4772
11	−25.3001	−27.1428
12	−21.0126	− 9.4144
13	−17.2592	+11.6990
14	−16.7924	−19.1677
15	−13.3035	− 7.0265
16	−11.2861	−24.6313
17	−10.5094	−25.6926
18	− 8.9976	− 5.7733
19	− 8.3180	+36.3499
20	− 7.4561	−18.9944
21	− 7.0791	−24.6935
22	− 6.6809	−21.3680
23	− 6.4892	−13.3514
24	− 6.3073	−13.4618
25	− 6.2310	+22.8062
26	− 6.2208	+19.6028
27	− 6.0568	− 2.1980
28	− 5.9784	−12.8662
29	− 5.7236	−15.2396
30	− 5.4013	−15.0276
32	− 3.7629	−40.8762
33	− 2.1678	+18.4888
34	− 0.6686	−18.5500
35	0.0000	0.0000
36	+ 0.1154	+ 6.6230
37	+ 0.6682	+23.2434
38	+ 0.6511	+50.6884
39	+ 1.4410	+16.4830
40	+ 2.0965	− 7.4155
41	+ 2.3082	−16.8187
42	+ 2.3856	+10.9278
43	+ 3.5647	−43.2516
44	+ 6.3231	−46.4360
45	+ 7.2018	− 5.6611
46	+ 8.0064	+27.7497
47	+ 8.2296	−21.8130
48	+10.2367	+56.9815
49	+10.7483	−43.3523
50	+11.4300	+25.1710
51	+11.6741	−28.2500
52	+12.3352	−27.5305
53	+13.2599	−12.0920
54	+13.5054	−18.4618
55	+14.3162	− 5.2012
56	+14.3930	+38.4282
57	+14.7057	+39.3148
58	+15.8305	−25.1796
59	+16.1945	−10.5251
60	+20.1984	+20.7906
61	+21.0784	−22.3990
62	+21.1346	− 8.4662
63	+22.9088	− 6.3596
64	+23.1428	+ 9.0459
65	+24.7174	−17.0339
66	+27.0432	−36.2064
67	+28.4791	+ 6.9701
68	+30.5804	+46.2926
69	+31.6057	+35.2655
70	+32.8448	+10.6274
71	+34.1023	−32.6075
72	+33.9394	+10.4872
73	+34.3568	−40.1846
74	+35.4148	+ 3.5899
75	+36.0087	−11.2562
76	+38.3552	−38.5986
77	+38.4861	+ 3.8162
78	+38.7955	−34.5510
79	+38.8936	−34.6129
80	+41.8852	−39.5898
82	+42.2553	−17.6267
83	+41.9135	+33.7545
84	+44.6777	−16.2750
85	+46.5116	+33.2166
86	+49.0634	−33.8387
87	+52.2426	+13.4712
88	+52.8326	+12.4661

PLATE 4.

Star.	*X*	*Y*
1	−40.4184	+ 3.8914
2	−39.9974	+ 3.1962
3	−36.6859	+30.3994
4	−35.1950	−28.1198
5	−33.5754	− 9.0606
6	−31.6124	− 2.1950
7	−31.6218	− 6.6117
8	−28.9794	+19.3569
9	−28.0688	−17.8397
10	−26.2599	+23.4682
11	−25.2956	−27.1470
12	−21.0095	− 9.4246
13	−17.2554	+11.7001
14	−16.7886	−19.1619
15	−13.3059	+ 7.0198
16	−11.2861	−24.6345
17	−10.5044	−25.6943
18	− 9.0016	− 5.7770
19	− 8.3262	+36.3522
20	− 7.4594	−19.0017
21	− 7.0753	−24.6946
22	− 6.6782	−21.3692
23	− 6.4866	−13.3557
24	− 6.3033	−13.4643
25	− 6.2337	+22.8062
26	− 6.2130	+19.5982
27	− 6.0494	− 2.2162
28	− 5.9775	−12.8674
29	− 5.7220	−15.2424
30	− 5.3964	−15.0303
32	− 3.7544	−40.8791
33	− 2.1645	+18.4841
34	− 0.6376	−18.5568

Table II.—Corrected Coördinates, 27 Cygni.—*Continued.*

Plate 4.

Star.	*X*	*Y*
35	0.0000	0.0000
36	+ 0.1102	+ 6.6212
37	+ 0.6609	+23.2419
38	+ 0.6478	+50.6824
39	+ 1.4447	+16.4793
41	+ 2.3114	—16.8234
43	+ 3.5741	—43.2567
44	+ 6.3253	—46.4402
45	+ 7.2002	— 5.6714
46	+ 8.0010	+27.7482
48	+10.2302	+56.9826
50	+11.4250	+25.1674
51	+11.6809	—28.2514
52	+12.3292	—27.5340
53	+13.2572	—12.0950
54	+13.5117	—18.4630
55	+14.3139	— 5.2033
56	+14.3834	+38.4191
57	+14.6982	+39.3119
58	+15.8332	—25.1817
59	+16.1949	—10.5278
60	+20.1892	+20.7870
61	+21.0854	—22.4048
62	+21.1380	— 8.4672
63	+22.9160	— 6.3639
64	+23.1222	+ 9.0449
65	+24.7197	—17.0386
66	+27.0461	—36.2028
67	+28.4727	+ 6.9687
68	+30.5690	+46.2876
69	+31.6025	+35.2640
70	+32.8419	+10.6242
71	+34.1064	—32.6064
72	+33.9327	+10.4856
73	+34.3592	—40.1911
74	+35.4109	+ 3.5880
75	+36.0122	—11.2477
76	+38.3755	—38.6158
77	+38.4903	+ 3.8144
78	+38.7940	—34.5538
79	+38.8908	—34.6164
80	+41.9000	—39.5988
81	+41.7963	+34.2979
82	+42.2616	—17.6253
83	+41.9034	+33.7560
84	+44.6809	—16.2776
85	+46.5003	+33.2009
86	+49.0708	—33.8424
87	+52.2345	+13.4715
88	+52.8253	+12.4692

Plate 5.

Star.	*X*	*Y*
1	—40.4116	+ 3.9277
2	—39.9960	+ 3.2350
3	—36.6557	+30.4313
4	—35.2332	—28.0825
5	—33.5835	— 9.0276
6	—31.6180	— 2.1581
7	—31.6326	— 6.5757
8	—28.9626	+19.3768
9	—28.0974	—17.8122
10	—26.2282	+23.4910
11	—25.3268	—27.1178
12	—21.0380	— 9.3951
14	—16.8036	—19.1609
15	—13.2944	+ 7.0342
16	—11.3105	—24.6152
17	—10.5352	—25.6771
18	— 9.0073	— 5.7621
20	— 7.4877	—18.9868
21	— 7.1008	—24.6834
22	— 6.7042	—21.3581
23	— 6.5035	—13.3436
24	— 6.3232	—13.4531
25	— 6.2086	+22.8082
27	— 6.0578	— 2.1995
28	— 5.9937	—12.8586
29	— 5.7380	—15.2320
30	— 5.4183	—15.0192
31	— 5.3511	—52.1984
32	— 3.7945	—40.8663
33	— 2.1477	+18.4854
35	0.0000	0.0000
36	+ 0.1190	+ 6.6256
37	+ 0.6915	+23.2414
39	+ 1.4592	+16.4809
40	+ 2.0707	— 7.4130
41	+ 2.2886	—16.8181
43	+ 3.5173	—43.2474
44	+ 6.2775	—46.4322
46	+ 8.0298	+27.7438
48	+10.2908	+56.9749
49	+10.7020	—43.3480
50	+11.4493	+25.1594
51	+11.6476	—28.2512
52	+12.3038	—27.5310
53	+13.2477	—12.0946
54	+13.4868	—18.4683
55	+14.3176	— 5.2095
56	+14.4315	+38.4134
57	+14.7491	+39.3017
58	+15.8010	—25.1844
59	+16.1798	—10.5321
60	+20.2094	+20.7729
61	+21.0537	—22.4112
62	+21.1207	— 8.4762
64	+23.1363	+ 9.0358
65	+24.6933	—17.0495
66	+27.0036	—36.2170
68	+30.6192	+46.2687
69	+31.6364	+35.2362
70	+32.8532	+10.5994
71	+34.0672	—32.6202
72	+33.9420	+10.4654
73	+34.3167	—40.2038
74	+35.4139	+ 3.5692
76	+38.3140	—38.6192
77	+38.4909	+ 3.7937
78	+38.7545	—34.5688
79	+38.8523	—34.6338
80	+41.8550	—39.6146
81	+41.8392	+34.2669
82	+42.2378	—17.6518
83	+41.9370	+33.7271
84	+44.6559	—16.2977
85	+46.5359	+33.1647
86	+49.0245	—33.8611
87	+52.2490	+13.4299
88	+52.8361	+12.4313

Plate 6.

Star.	*X*	*Y*
1	- 40.4129	+ 3.9198
2	—39.9902	+ 3.2265
3	—36.6575	+30.4245
4	—35.2250	—28.0949
6	—31.6135	— 2.1685
7	—31.6273	— 6.5870
8	—28.9588	+19.3700
9	—28.0919	—17.8189
10	—26.2217	+23.4889
11	—25.3208	—27.1214
13	—17.2446	+11.7062
15	—13.2969	+ 7.0358
16	—11.3076	—24.6186
17	—10.5301	—25.6794
18	— 9.0008	— 5.7669
21	— 7.0960	—24.6810
22	— 6.6935	—21.3633
23	— 6.4990	—13.3407
24	— 6.3179	- 13.4496
25	— 6.2110	+22.8053

TABLE II.—CORRECTED COÖRDINATES, 27 CYGNI.—*Continued.*

PLATE 6.

Star.	*X*	*Y*
27	— 6.0531	— 2.2024
28	— 5.9881	—12.8574
29	— 5.7331	—15.2328
30	— 5.4092	—15.0193
32	— 3.7894	—40.8682
35	0.0000	0.0000
36	+ 0.1231	+ 6.6216
37	+ 0.6886	+23.2405
38	+ 0.6980	+50.6748
39	+ 1.4543	+16.4753
41	+ 2.2957	—16.8158
43	+ 3.5319	—43.2465
44	+ 6.2876	—46.4334
46	+ 8.0280	+27.7419
48	+10.2857	+56.9740
49	+10.7184	—43.3406
50	+11.4485	+25.1608
51	+11.6546	—28.2484
52	+12.3132	—27.5312
53	+13.2496	—12.0919
54	+13.4916	—18.4673
55	+14.3222	— 5.2091
57	+14.7438	+39.3070
58	+15.8070	—25.1836
59	+16.1868	—10.5311
60	+20.2024	+20.7744
61	+21.0647	—22.4091
62	+21.1353	— 8.4747
64	+23.1396	+ 9.0342
65	+24.7018	—17.0451
66	+27.0144	—36.2139
67	+28.4701	+ 6.9567
68	+30.6168	+46.2720
69	+31.6322	+35.2396
70	+32.8485	+10.6029
71	+34.0764	—32.6198
72	+33.9472	+10.4679
73	+34.3249	—40.2057
74	+35.4162	+ 3.5712
76	+38.3209	—38.6176
77	+38.4927	+ 3.7946
78	+38.7631	—34.5692
79	+38.8620	—34.6305
80	+41.8672	—39.6096
81	+41.8386	+34.2686
82	+42.2448	—17.6466
83	+41.9344	+33.7280
84	+44.6610	—16.2951
85	+46.5332	+33.1713
86	+49.0314	—33.8512
87	+52.2497	+13.4396
88	+52.8392	+12.4401

PLATE 7.

Star.	*X*	*Y*
1	—40.4200	+ 3.9208
2	—40.0004	+ 3.2266
3	—36.6646	+30.4272
5	—33.5845	— 9.0300
6	—31.6207	— 2.1642
7	—31.6362	— 6.5806
8	—28.9654	+19.3740
9	—28.0957	—17.8133
10	—26.2404	+23.4902
11	—25.3236	—27.1238
13	—17.2578	+11.7078
15	—13.3022	+ 7.0357
16	—11.3114	—24.6196
17	—10.5316	—25.6792
18	— 9.0098	— 5.7574
21	— 7.1006	—24.6824
22	— 6.7038	—21.3580
23	— 6.5018	—13.3407
24	— 6.3205	—13.4535
25	— 6.2137	+22.8041
28	— 5.9955	—12.8541
29	— 5.7354	—15.2338
30	— 5.4150	—15.0211
32	— 3.7912	—40.8656
35	0.0000	0.0000
36	+ 0.1191	+ 6.6263
38	+ 0.6893	+50.6820
39	+ 1.4494	+16.4775
41	+ 2.2898	—16.8189
43	+ 3.5260	—43.2412
44	+ 6.2866	—46.4309
46	+ 8.0244	+27.7446
48	+10.2778	+56.9754
50	+11.4413	+25.1616
51	+11.6491	—28.2485
52	+12.3078	—27.5322
53	+13.2426	—12.0967
54	+13.4874	—18.4636
55	+14.3113	— 5.2051
58	+15.8047	—25.1833
59	+16.1768	—10.5292
60	+20.2042	+20.7770
61	+21.0600	—22.4085
62	+21.1224	— 8.4727
65	+24.6984	—17.0417
66	+27.0125	—36.2102
67	+28.4728	+ 6.9620
68	+30.6098	+46.2740
69	+31.6289	+35.2422
70	+32.8470	+10.6078
71	+34.0762	—32.6195
72	+33.9434	+10.4724
73	+34.3235	—40.1977
74	+35.4140	+ 3.5802
75	+36.0046	—11.2621
76	+38.3243	—38.6127
77	+38.4892	+ 3.8010
78	+38.7621	—34.5665
79	+38.8628	—34.6240
80	+41.8693	—39.6126
81	+41.8241	+34.2728
82	+42.2423	—17.6445
84	+44.6664	—16.2893
85	+46.5323	+33.1750
86	+49.0383	—33.8501
87	+52.2450	+13.4439
88	+52.8360	+12.4400

PLATE 8.

Star.	*X*	*Y*
1	—40.4183	+ 3.9270
2	—39.9983	+ 3.2327
3	—36.6628	+30.4355
5	—33.5836	— 9.0324
6	—31.6228	— 2.1561
8	—28.9626	+19.3854
9	—28.0997	—17.8127
10	—26.2284	+23.5004
11	—25.3316	—27.1208
12	—21.0378	— 9.3981
15	—13.2993	+ 7.0327
16	—11.3060	—24.6182
17	—10.5418	—25.6828
18	— 9.0074	— 5.7616
20	— 7.4770	—18.9925
21	— 7.1006	—24.6836
22	— 6.7069	—21.3606
23	— 6.5026	—13.3498
24	— 6.3198	—13.4561
25	— 6.2098	+22.8098
27	— 6.0532	— 2.1921
28	— 5.9970	—12.8598

TABLE II.—CORRECTED COÖRDINATES, 27 CYGNI.—*Concluded.*

PLATE 8.			PLATE 8.			PLATE 8.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
29	− 5.7344	−15.2340	52	+12.3134	−27.5354	70	+32.8583	+10.5967
30	− 5.4184	−15.0208	53	+13.2475	−12.1010	71	+34.0712	−32.6263
31	− 5.3610	−52.1988	54	+13.4882	−18.4701	72	+33.9489	+10.4637
32	− 3.8032	−40.8698	55	+14.3206	− 5.2109	73	+34.3262	−40.2102
34	− 0.6429	−18.5554	57	+14.7534	+39.3029	74	+35.4255	+ 3.5656
35	0.0000	0.0000	58	+15.8064	−25.1948	76	+38.3320	−38.6262
36	+ 0.1132	+ 6.6284	59	+16.1862	−10.5365	77	+38.4982	+ 3.7883
38	+ 0.6994	+50.6852	60	+20.2173	+20.7777	78	+38.7621	−34.5753
39	+ 1.4594	+16.4790	61	+21.0611	−22.4094	79	+38.8605	−34.6378
43	+ 3.5204	−43.2485	62	+21.1338	− 8.4788	80	+41.8561	−39.6182
44	+ 6.2821	−46.4325	64	+23.1292	+ 9.0292	82	+42.2455	−17.6556
46	+ 8.0303	+27.7453	65	+24.7051	−17.0518	83	+41.9441	+33.7285
48	+10.2927	+56.9730	66	+27.0064	−36.2234	85	+46.5517	+33.1634
49	+10.7094	−43.3456	67	+28.4746	+ 6.9522	86	+49.0353	−33.8656
50	+11.4542	+25.1585	68	+30.6254	+46.2721	87	+52.2639	+13.4285
51	+11.6467	−28.2541	69	+31.6400	+35.2443	88	+52.8525	+12.4306

TABLE III.—REFRACTION COEFFICIENTS, 27 CYGNI.

Plate.	M_x	N_x	M_y	N_y
1	+0.000578	—0.000074	+0.000340	+0.000361
2	+ .000562	— .000081	+ .000320	+ .000360
3	+ .000438	— .000085	+ .000214	+ .000312
4	+ .000524	— .000077	+ .000297	+ .000336
5	+ .000418	+ .000083	— .000200	+ .000302
6	+ .000373	+ .000079	— .000154	+ .000293
7	+ .000339	+ .000070	— .000117	+ .000287
8	+ .000314	+ .000057	— .000086	+ .000284

TABLE IV.—PLATE CONSTANTS, 27 CYGNI.

Plate.	p	r	Probable Error of p or r.	k	c	Probable Error of k or c.	Probable Error of One Equation.
1	—0.000092	+0.000025	±0.000008	+0.″168	+0.″393	±0.″015	±0.″1060
2	— .000068	+ .001301	.000013	+ .183	+ .138	.025	.1796
3	— .000055	+ .000435	.000006	— .061	— .047	.012	.0875
4	— .000087	+ .000561	.000008	— .091	+ .144	.016	.1187
5	+ .000087	— .000695	.000005	— .022	— .167	.010	.0727
6	+ .000115	— .000520	.000006	— .180	— .101	.012	.0880
7	+ .000093	— .000457	.000006	+ .095	— .211	.011	.0793
8	+ .000005	+ .000653	.000007	— .091	— .152	.014	.1044

TABLE V.—27 CYGNI MEAN *X* AND RESIDUALS FOR EACH PLATE.

Star.	X_m	1	2	3	4	5	6	7	8
1	—2137″.88	—″.14	+″.13	—″.11	+″.03	+″.10	—″.06	—″.04	+″.06
2	—2115.61	+.01	+.10	+.07	+.02	—.18	+.04	—.10	+.04
3	—1939.83	—.19	+.56	—.05	+.09	—.15	—.08	.00	—.20
4	—1862.69	+.23	—.16	—.16	+.31	—.14	—.09		
5	—1776.13	—.01	+.07	—.12	—.10	—.06		+.02	+.19
6	—1672.35	—.07	+.07	+.09	+.12	—.08	.00	—.02	—.10
7	—1673.03		—.14	+.02	+.20	—.04	+.04	—.08	
8	—1532.41	+.02	+.41	—.18	.00	—.25	—.02	+.05	—.02
9	—1485.58	—.02	+.05	—.11	+.38	—.13	—.12	—.02	—.06
10	—1388.14	—.06	+.18	—.15	—.32	—.02	+.40	—.17	+.16
11	—1338.80	+.18	—.02	+.10	+.05	—.05	—.11	+.02	—.14
12	—1112.04	—.05	+.02	+.44	+.45	—.52			—.37
13	— 912.73	—.39	+.18	+.05	+.25		+.12	—.23	
14	— 888.46		+.02	—.10	—.12	+.20			
15	— 703.60	+.03	+.10	+.04	—.10	+.13	—.09	—.04	—.07
16	— 597.60	—.01	—.25	+.16	—.08	+.08	—.12	—.09	+.34
17	— 556.54	—.08	—.11	+.17	+.18	+.08	—.05	+.10	—.27
18	— 476.24	—.12	+.11	+.19	—.12	—.06	+.10	—.10	—.04
19	— 439.56	—.37	+.12	+.23	.00				
20	— 395.10	+.12	—.20	+.34	—.03	—.38			+.17
21	— 374.99	+.01	—.45	+.06	+.03	+.16	+.04	+.02	+.15
22	— 353.94	+.06	—.18	+.14	+.06	—.02	+.20	—.11	—.18
23	— 343.60	+.07	—.27	+.08	+.06	.00	—.04	+.07	+.03
24	— 334.02	—.10	—.28	+.11	+.18	—.05	—.04	+.09	+.12
25	— 329.16	—.18	+.29	—.03	—.06	—.02	—.09	+.12	—.06
26	— 328.42	+.05	+.06	—.30	+.21				
27	— 320.22	.00	+.31	—.22	+.10	—.17	—.10		+.07
28	— 316.68	+.11	—.16	+.18	+.08	+.02	+.06	—.08	—.17
29	— 303.02	+.10	—.07	—.05	—.12	—.04	—.05	+.07	+.13
30	— 286.03	+.11	—.04	+.01	+.12	—.13	+.08	+.01	—.16
31	— 281.80		—.25			+.42			—.18
32	— 199.74	+.03	—.29	—.10	+.02	+.32	+.07	+.14	—.20
33	— 114.11	+.05	+.32	—.26	.00	—.12			
34	— 33.89	—.25	+.01	+.25	—.39				+.38
35	0.00	+.17	+.18	—.06	—.09	—.02	—.18	+.10	—.09
36	+ 6.09	—.01	+.35	+.07	—.19	—.03	+.09	+.17	—.41
37	+ 35.78	+.17	—.26	—.07	—.32	+.03	—.07		
38	+ 35.50	—.21	+.55	—.19	—.03		+.06	+.01	—.20
39	+ 76.57	—.02	+.24	—.11	+.17	+.06	—.20	—.14	.00
40	+ 110.09		—.26	+.59		—.33			
41	+ 121.68	+.16	+.01	+.03	+.05	—.10	—.04	+.14	
42	+ 126.19	—.28	+.16	+.13					
43	+ 187.52	—.02	—.40	+.15	+.33	—.08	+.13	—.04	—.06
44	+ 333.46	—.08	—.18	+.05	—.17	+.09	+.04	+.11	+.15
45	+ 380.57	—.23	+.02	+.18	+.03				
46	+ 423.89	+.04	+.23	+.04	—.07	—.06	—.07	+.06	—.17
47	+ 434.64	+.04	—.20	+.17					
48	+ 542.49	—.36	+.37	—.08	—.02	—.01	+.07	+.06	—.02
49	+ 567.63	—.03		—.01		—.15	+.16		+.04

TABLE V. — 27 CYGNI MEAN *Y* AND RESIDUALS FOR EACH PLATE.

Star.	Y_m	1	2	3	4	5	6	7	8
	″	″	″	″	″	″	″	″	″
1	+ 206.38	+.22	—.54	+.01	+.13	+.13	+.06	+.05	—.07
2	+ 169.69	—.01	—.36	+.07	+.04	+.18	+.09	+.04	—.08
3	+1608.28	—.13	—.36	+.08	—.01	+.12	+.10	+.15	+.06
4	—1486.54	—.08	—.15	+.21	+.11	+.15	—.23		
5	— 478.64	+.13	—.33	—.04	+.10	+.11		+.23	—.20
6	— 115.40	—.14	—.43	.00	—.10	+.26	.00	+.17	+.28
7	— 349.07		—.57	+.08	.00	+.27	—.03	+.24	
8	+1024.04	+.23	—.25	+.13	+.15	—.11	—.19	—.08	+.14
9	— 943.03	+.10	—.31	—.07	+.15	+.04	—.09	+.16	00
10	+1241.68	+.10	—.36	+.14	—.09	—.08	+.07	+.04	+.21
11	—1435.18	+.01	—.19	+.01	+.06	+.08	+.10	—.07	—.02
12	— 497.74	+.29	—.17	+.07	—.23	+.11			—.06
13	+ 618.82	+.10	—.21	+.02	+.29		—.09	—.11	
14	—1013.55		—.14	+.04	+.58	—.49			
15	+ 371.56	+.13	—.36	+.14	.00	—.03	+.22	+.11	—.18
16	—1302.50	+.02	—.21	—.02	+.04	+.12	+.06	—.05	+.07
17	—1358.58	+.13	—.16	—.06	+.08	+.06	+.05	+.01	—.13
18	— 305.17	+.01	—.08	—.08	—.06	+.01	—.14	+.29	+.03
19	+1922.40	+.23	—.49	—.04	+.28				
20	—1104.60	+.08	—.04	+.15	—.03	+.01			—.19
21	—1305.78	+.06	—.18	—.07	+.10	—.08	+.14	—.01	+.02
22	—1130.04	—.08	—.22	+.05	+.21	+.06	—.13	+.08	+.03
23	— 706.05	+.15	—.17	+.01	—.01	—.04	+.21	+.14	—.30
24	— 711.87	+.13	—.32	—.02	+.06	.00	+.28	—.01	—.09
25	+1206.02	—.03	.00	+.08	+.27	—.01	—.03	—.23	—.06
26	+1036.48	—.15	—.25	+.21	+.17				
27	— 116.61	—.10	—.08	+.39	—.37	—.06	—.10		+.35
28	— 680.36	—.09	—.15	—.03	+.12	—.07	+.09	+.18	—.06
29	— 805.97	—.08	—.14	+.07	+.12	+.02	+.07	—.05	.00
30	— 794.71	—.04	—.10	+.01	+.09	+.02	+.11	—.08	.00
31	—2760.96		+.06			—.15			+.10
32	—2161.72	—.04	—.18	+.05	+.09	+.02	—.03	+.06	+.05
33	+ 977.54	—.04	—.21	+.19	+.12	—.07			
34	— 981.24	+.02	—.07	+.21	+.05				—.23
35	0.00	+.39	+.14	—.05	+.14	—.17	—.10	—.21	—.15
36	+ 350.25	+.08	—.14	—.05	+.04	+.03	—.13	+.01	+.15
37	+1229.13	—.15	+.05	+.01	+.11	—.03	+.01		
38	+2680.37	+.04	—.04	+.16	+.01		—.19	+.01	.00
39	+ 871.49	+.18	—.04	+.13	+.10	+.06	—.15	—.17	—.10
40	— 392.23		—.02	.00		+.03			
41	— 889.61	—.07	—.09	+.10	+.05	—.02	+.14	—.12	
42	+ 577.88	+.21	—.14	—.06					
43	—2287.36	+.06	—.10	—.02	—.09	—.10	—.05	+.18	+.10
44	—2455.84	+.10	—.30	+.02	.00	+.01	—.07	+.01	+.27
45	— 299.67	+.28	—.24	+.16	—.21				
46	+1467.39	+.02	—.05	—.02	+.06	+.03	—.03	—.04	+.01
47	—1153.52	+.18	.00	—.18					
48	+3013.35	+.15	—.10	—.13	+.07	+.18	+.19	+.06	—.16
49	—2292.32	+.51		—.49		—.27	+.08		+.15

TABLE V.—27 CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.—*Continued.*

Star.	X_m	1	2	3	4	5	6	7	8
	″	″	″	″	″	″	″	″	″
50	+ 604.88	−.05	+.31	+.05	−.02	−.10	−.06	−.14	+.02
51	+ 616.87	−.03	−.21	.00	+.16	+.15	+.09	−.04	−.12
52	+ 651.70	−.04	−.09	+.14	−.38	.00	+.08	−.05	+.30
53	+ 700.97	+.15	+.02	+.06	−.15	+.16	−.02	−.18	−.06
54	+ 713.92	+.12	−.14	−.03	+.19	+.07	−.02	−.06	−.09
55	+ 757.25	−.04	−.02	−.22	−.36	+.26	−.27	−.08	+.20
56	+ 761.90			.00	−.23	+.22			
57	+ 778.68			−.22	−.33	+.20	+.10		+.25
58	+ 836.60	+.09	−.34	+.16	+.13	+.02	−.07	−.04	+.04
59	+ 856.19	+.08	−.12	+.09	+.04	−.01	+.10	−.24	+.09
60	+1068.39	+.10	+.19	+.24	−.08	−.07	−.43	−.06	+.10
61	+1114.39	−.20	−.35	−.02	+.22	−.01	+.19	+.09	+.08
62	+1117.64	−.18	−.11	−.04	+.11	−.17	+.34	−.15	+.23
63	+1211.21	−.67	−.22	+.26	+.64				
64	+1223.44	−.19	+.13	+.70	−.30	+.09	+.16		−.58
65	+1306.80	−.32	−.16	+.14	+.17	−.07	+.04	+.01	+.22
66	+1429.49	+.11	−.40	+.10	+.05	+.06	+.12	+.11	−.16
67	+1505.85	−.18	−.20	+.49	+.25		−.25	+.11	−.23
68	+1618.20	−.08	+.41	.00	−.22	−.06	+.03	−.01	−.07
69	+1672.31	−.13	+.41	−.10	+.06	−.01	−.11	+.01	−.16
70	+1737.30	−.04	+.09	.00	−.01	+.17	−.18	−.05	+.05
71	+1802.99	+.04	−.33	+.03	+.08	+.08	+.08	+.16	−.14
72	+1795.14	−.08	+.19	+.06	−.16	−.08	+.10	+.11	−.11
73	+1816.35	+.20	−.55	−.02	−.11	+.17	+.06	+.04	+.24
74	+1873.14	−.09	+.05	−.04	−.15	.00	−.05	+.02	+.20
75	+1904.41		−.12	−.17	+.01			+.29	
76	+2027.96	−.27	−.58	−.12	+.76	−.05	−.22	+.01	+.42
77	+2035.85	+.08	+.18	−.31	+.02	+.05	−.01	−.04	−.01
78	+2051.20	+.87	.00	+.01	−.25	−.11	−.16	−.17	−.20
79	+2056.31	+.33	−.05	+.08	−.23	−.05	−.04	+.06	−.10
80	+2215.10	+.11	−.02	−.57	+.01	+.14	+.24	+.38	−.32
81	+2211.94	−.18	+.69		−.41	+.09	+.17	−.35	
82	+2234.69	−.04	−.15	−.18	+.11	+.09	+.11	+.08	+.01
83	+2217.28	−.08	+.39	+.10	−.11	−.06	−.10		−.14
84	+2362.74	−.15	+.19	−.09	+.06	−.08	−.16	+.21	
85	+2460.66	+.18	+.50	−.09	−.36	−.16	−.20	−.03	+.17
86	+2594.37	−.02	+.07	−.08	+.18	−.06	−.20	+.18	−.07
87	+2763.34	−.16	+.33	−.02	−.23	.00	−.04	−.13	+.22
88	+2794.49	−.16	+.17	.00	−.17	−.07	+.01	.00	+.23

TABLE V. — 27 CYGNI MEAN *Y* AND RESIDUALS FOR EACH PLATE. — *Continued.*

Star.	Y_m	1	2	3	4	5	6	7	8
	″	″	″	″	″	″	″	″	″
50	+1330.84	−.12	+.05	+.12	+.08	−.01	+.07	−.05	−.13
51	−1494.03	+.18	−.02	−.12	−.02	−.05	+.06	−.04	+.02
52	−1456.05	+.02	+.05	−.05	−.06	+.08	+.02	−.13	+.04
53	− 639.59	+.12	+.09	−.08	−.06	+.08	+.18	−.17	−.13
54	− 976.53	+.02	+.01	.00	+.10	−.08	−.08	+.02	−.01
55	− 275.24	+.04	+.27	−.04	+.01	−.08	−.11	−.01	−.07
56	+2031.86			+.14	−.19	+.06			
57	+2078.94			−.06	−.07	−.03	+.26		−.11
58	−1331.84	+.18	−.08	+.01	+.07	+.07	+.04	−.03	−.27
59	− 556.80	+.09	+.07	−.04	−.03	+.01	+.01	−.01	−.08
60	+1099.11	−.11	−.05	+.09	+.04	−.06	−.03	−.05	+.18
61	−1184.86	−.04	+.29	+.03	−.13	−.10	−.09	−.16	+.21
62	− 447.91	−.03	+.23	−.11	−.02	−.02	−.02	−.04	−.01
63	− 336.62	+.15	−.02	−.02	−.10				
64	+ 478.23	+.21	+.13	−.17	−.09	+.12	−.05		−.18
65	− 901.18	−.07	+.12	+.03	−.07	−.10	+.03	+.08	−.02
66	−1914.94	+.04	+.09	−.14	+.19	−.06	−.05	+.06	−.08
67	+ 368.40	+.01	+.22	−.18	−.13		.00	+.12	−.03
68	+2447.78	−.18	+.24	−.07	−.23	+.04	+.11	.00	+.10
69	+1864.54	−.04	+.40	+.02	+.05	−.21	−.15	−.23	+.17
70	+ 561.46	−.07	+.45	+.13	+.07	−.16	−.12	−.04	−.21
71	−1724.69	−.04	+.16	−.16	+.03	+.12	−.07	−.15	+.10
72	+ 554.25	.00	+.16	−.10	−.07	.00	−.03	+.04	+.01
73	−2125.73	−.15	.00	+.18	−.03	+.07	−.25	+.08	+.08
74	+ 189.52	−.09	+.13	−.13	−.12	+.02	−.05	+.26	−.05
75	− 595.40		−.07	−.34	+.22			+.18	
76	−2041.83	+.21	+.23	+.09	−.70	+.07	−.07	+.08	+.07
77	+ 201.42	+.04	+.09	−.10	−.10	+.07	−.07	+.10	−.07
78	−1827.71	−.28	−.04	+.03	.00	+.20	−.07	−.02	+.19
79	−1830.93	−.12	+.04	−.02	−.09	−.02	−.08	+.15	+.11
80	−2094.28	−.20	+.49	+.09	−.27	−.02	−.02	−.29	+.18
81	+1813.38	+.02	+.39		−.04	−.07	−.15	−.15	
82	− 932.59	−.11	+.41	−.10	+.06	−.09	−.05	−.08	−.02
83	+1784.73	−.08	+.26	−.21	−.05	+.04	−.09		+.13
84	− 861.06	+.03	+.27	−.19	−.23	+.06	−.05	+.10	
85	+1755.44	−.21	+.74	+.59	−.18	−.28	−.16	−.20	−.34
86	−1789.81	−.07	+.32	−.32	−.42	−.01	+.22	+.16	+.14
87	+ 711.73	−.27	+.45	+.01	+.10	−.22	+.02	+.04	−.16
88	+ 658.78	−.13	+.29	−.19	+.04	−.07	+.12	−.10	+.04

TABLE VI. — 27 CYGNI CONCORDANCE WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.
1	8966	18	9004	38	9018	68	9059
2	8967	22	9005	39	9019	70	9061
3	8974	24	9006	41	9021	71	9065
5	8977	25	9007	46	9026	72	9066
6	8978	28	9008	48	9032	79	9069
9	8982	29	9010	50	9033	82	9072
11	8985	30	9011	51	9034	83	9073
13	8991	31	9012	54	9036	86	9079
14	8993	32	9014	55	9037	87	9085
17	9000	35	9016	66	9050	88	9086

TABLE VII. — 27 CYGNI COMPARISON WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

$p = +0.000412 \quad \pm 0.000034$
$r = +0.000115 \quad \pm 0.000034$
$k = +0''.747 \quad \pm 0''.067$
$c = +0''.584 \quad \pm 0''.067$
Probable error of a single equation $= \pm 0.4211$

RESIDUALS.

Star.	v_x	v_y	Star.	v_x	v_y
	″	″		″	″
1	+0.05	−0.26	38	−0.87	−0.30
2	+1.04	+0.09	39	−1.07	+1.01
3	+0.21	−0.32	41	−0.17	+0.47
5	+0.06	−0.40	46	+0.07	−0.31
6	−0.78	−0.62	48	+0.19	−0.34
9	−0.80	−0.75	50	−0.40	+0.34
11	−0.72	−0.18	51	+0.51	+0.04
13	−0.45	−0.29	54	+0.78	−0.30
14	+0.69	−0.13	55	+1.02	+0.95
17	−0.41	+0.79	66	−1.47	+0.26
18	−0.96	+0.45	68	+0.97	−0.09
22	+0.26	+0.01	70	+0.65	+0.40
24	+0.55	+0.37	71	0.00	−0.44
25	−0.12	−0.66	72	+0.30	−0.29
28	−0.10	−0.19	79	+1.44	−0.10
29	−0.26	+0.16	82	−0.92	+0.35
30	+0.47	+0.45	83	+0.01	−0.16
31	−1.58	−0.75	86	−0.74	+0.38
32	+1.39	+0.41	87	+0.04	−0.60
35	+0.75	+0.58	88	+0.39	−0.06

TABLE VIII. — 27 CYGNI FINAL COÖRDINATES.

Star.	*X*	*Y*	Star.	*X*	*Y*
	″	″		″	″
1	−2137.99	+ 207.30	45	+ 381.45	− 299.25
2	−2115.71	+ 170.58	46	+ 424.98	+1468.52
3	−1939.70	+1609.74	47	+ 435.44	−1153.47
4	−1862.88	−1486.36	48	+ 543.81	+3015.11
5	−1776.17	− 478.06	49	+ 568.35	−2292.75
6	−1672.30	− 114.68	50	+ 606.03	+1331.90
7	−1673.01	− 348.44	51	+ 617.70	−1494.14
8	−1532.17	+1025.22	52	+ 652.55	−1456.14
9	−1485.55	− 942.67	53	+ 701.94	− 639.35
10	−1387.82	+1242.93	54	+ 714.85	− 976.43
11	−1338.77	−1435.04	55	+ 758.28	− 274.86
12	−1111.81	− 497.24	56	+ 763.19	+2033.19
13	− 912.29	+ 619.75	57	+ 779.99	+2080.29
14	− 888.20	−1013.29	58	+ 837.54	−1331.91
15	− 703.10	+ 372.37	59	+ 857.23	− 556.55
16	− 597.25	−1302.39	60	+1069.71	+1100.02
17	− 556.18	−1358.50	61	+1115.46	−1184.90
18	− 475.73	− 304.67	62	+1118.80	− 447.64
19	− 438.77	+1923.82	63	+1212.42	− 336.32
20	− 394.63	−1004.38	64	+1224.74	+ 478.87
21	− 374.54	−1305.70	65	+1307.99	− 901.12
22	− 353.47	−1129.89	66	+1430.61	−1915.31
23	− 343.07	− 705.72	67	+1507.26	+ 368.96
24	− 333.49	− 711.54	68	+1619.90	+2449.18
25	− 328.41	+1207.14	69	+1673.96	+1865.70
26	− 327.69	+1037.53	70	+1738.83	+ 562.07
27	− 319.61	− 116.04	71	+1804.28	−1725.03
28	− 316.14	− 680.02	72	+1796.69	+ 554.85
29	− 302.48	− 805.69	73	+1817.61	−2126.24
30	− 285.49	− 794.43	74	+1874.68	+ 189.96
31	− 281.49	−2761.49	75	+1905.87	− 595.29
32	− 199.32	−2162.01	76	+2029.32	−2042.32
33	− 113.30	+ 978.53	77	+2037.46	+ 201.85
34	− 33.26	− 981.06	78	+2052.59	−1828.12
35	+ 0.75	+ 0.58	79	+2057.70	−1831.34
36	+ 6.88	+ 350.97	80	+2216.52	−2094.81
37	+ 36.68	+1230.22	81	+2213.81	+1814.46
38	+ 36.57	+2682.05	82	+2236.25	− 932.65
39	+ 77.45	+ 872.42	83	+2219.15	+1785.80
40	+ 110.84	− 391.82	84	+2364.36	− 861.10
41	+ 122.38	− 889.41	85	+2462.62	+1756.46
42	+ 127.06	+ 578.69	86	+2595.98	−1790.27
43	+ 188.09	−2287.74	87	+2765.31	+ 712.28
44	+ 334.07	−2456.31	88	+2796.47	+ 659.31

TABLE IX.—27 CYGNI DIAMETERS OF STAR-IMAGES.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r		r
1	0.102	23	0.107	45	0.100	67	0.118
2	0.252	24	0.248	46	0.173	68	0.233
3	0.187	25	0.116	47	0.095	69	0.131
4	0.140	26	0.126	48	0.271	70	0.116
5	0.125	27	0.131	49	0.111	71	0.156
6	0.124	28	0.185	50	0.100	72	0.132
7	0.119	29	0.118	51	0.116	73	0.163
8	0.104	30	0.156	52	0.120	74	0.121
9	0.126	31	0.184	53	0.117	75	0.112
10	0.114	32	0.156	54	0.206	76	0.153
11	0.131	33	0.136	55	0.108	77	0.118
12	0.126	34	0.147	56	0.125	78	0.127
13	0.125	35	0.262	57	0.130	79	0.179
14	0.125	36	0.108	58	0.111	80	0.163
15	0.128	37	0.109	59	0.104	81	0.144
16	0.138	38	0.160	60	0.109	82	0.190
17	0.174	39	0.138	61	0.117	83	0.146
18	0.127	40	0.117	62	0.115	84	0.134
19	0.128	41	0.139	63	0.128	85	0.168
20	0.129	42	0.119	64	0.112	86	0.131
21	0.128	43	0.129	65	0.121	87	0.171
22	0.197	44	0.134	66	0.135	88	0.192

TABLE X. — 27 CYGNI FINAL CATALOG.

No.	Mag	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	9.2	8	19 58 47.711	299 41 55.66	+2.2382	+33.5734	+0.0015	+0.0228	35 41 3.13	+ 9.9357	+0.2793	1875.91
2	7.3	8	58 49.561	299 42 23.42	2.2386	33.5789	0.0015	0.0228	35 40 26.58	9.9380	0.2793	75.91
3	7.9	8	59 3.204	299 45 48.06	2.2267	33.4010	0.0015	0.0228	36 4 26.85	9.9553	0.2776	75.91
4	8.5	6	59 11.183	299 47 47.75	2.2534	33.8006	0.0015	0.0231	35 12 51.52	9.9654	0.2809	75.72
5	8.8	7	59 17.751	299 49 26.26	2.2451	33.6761	0.0015	0.0230	35 29 40.28	9.9737	0.2798	75.82
6	8.8	8	59 26.083	299 51 31.24	+2.2423	+33.6341	+0.0015	+0.0231	35 35 44.26	+ 9.9842	+0.2793	75.91
7	8.9	6	59 26.136	299 51 32.04	2.2443	33.6639	0.0015	0.0231	35 31 50.50	9.9843	0.2796	75.98
8	9.1	8	59 37.071	299 54 16.07	2.2329	33.4938	0.0015	0.0230	35 54 44.88	9.9981	0.2780	75.91
9	8.8	8	59 41.742	299 55 26.13	2.2498	33.7473	0.0015	0.0232	35 21 57.33	10.0040	0.2801	75.91
10	9.0	8	59 48.865	299 57 12.98	2.2315	33.4720	0.0015	0.0231	35 58 23.32	10.0130	0.2777	75.91
11	8.7	8	59 53.927	299 58 28.90	+ 2.2544	+33.8157	+0.0016	+0.0233	35 13 45.71	+10.0195	+0.2805	75.91
12	8.8	6	20 0 12.154	300 3 2.31	2.2471	33.7064	0.0016	0.0234	35 29 24.41	10.0424	0.2793	75.72
13	8.8	6	0 28.199	300 7 2.98	2.2382	33.5724	0.0016	0.0234	35 48 2.08	10.0627	0.2780	75.72
14	8.8	4	0 30.592	300 7 38.88	2.2521	33.7812	0.0016	0.0235	35 20 49.15	10.0657	0.2797	75.74
15	8.7	8	0 45.443	300 11 21.65	2.2409	33.6130	0.0016	0.0235	35 43 55.30	10.0845	0.2781	75.91
16	8.6	8	0 54.420	300 13 36.30	+2.2553	+33.8299	+0.0016	+0.0236	35 16 0.81	+10.0958	+0.2798	75.91
17	8.1	8	0 57.783	300 14 26.74	2.2559	33.8387	0.0016	0.0237	35 15 4.78	10.1000	0.2799	75.91
18	8.7	8	1 4.208	300 16 3.12	2.2473	33.7089	0.0016	0.0236	35 32 38.73	10.1081	0.2787	75.91
19	8.7	4	1 6.956	300 16 44.34	2.2284	33.4255	0.0016	0.0234	36 9 47.21	10.1115	0.2763	75.34
20	8.7	6	1 10.931	300 17 43.96	2.2534	33.8010	0.0016	0.0237	35 20 59.15	10.1166	0.2794	75.72
21	8.7	8	1 12.605	300 18 9.07	+ 2.2560	+33.8397	+0.0016	+ 0.0237	35 15 57.87	+ 10.1187	+0.2797	75.91
22	7.8	8	1 14.308	300 18 34.62	2.2546	33.8185	0.0016	0.0238	35 18 53.70	10.1209	0.2795	75.91
23	9.1	8	1 15.116	300 18 46.74	2.2510	33.7654	0.0016	0.0237	35 25 57.87	10.1219	0.2790	75.91
24	7.4	8	1 15.901	300 18 58.51	2.2511	33.7666	0.0016	0.0237	35 25 52.06	10.1229	0.2790	75.91
25	8.9	8	1 16.136	300 19 2.04	2.2348	33.5224	0.0016	0.0236	35 57 50.73	10.1231	0.2770	75.91

TABLE X. — 27 CYGNI FINAL CATALOG. — *Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
26	8.8	4	20 1 16.212	300 19 3.18	+2.2363	+33.5443	+0.0016	+0.0236	35 55 1.12	+10.1232	+0.2772	1875.34
27	8.7	7	1 16.982	300 19 14.73	2.2461	33.6916	0.0016	0.0237	35 35 47.57	10.1242	0.2784	75.82
28	8.0	8	1 17.317	300 19 19.76	2.2509	33.7633	0.0016	0.0237	35 26 23.60	10.1246	0.2790	75.91
29	8.9	8	1 18.446	300 19 36.69	2.2520	33.7797	0.0016	0.0237	35 24 17.95	10.1260	0.2791	75.91
30	8.3	8	1 19.835	300 19 57.52	2.2519	33.7791	0.0016	0.0237	35 24 29.22	10.1278	0.2791	75.91
31	8.0	3	1 20.317	300 20 4.76	+2.2684	+34.0262	+0.0016	+0.0238	34 51 42.33	+10.1284	+0.2812	75.94
32	8.3	8	1 26.959	300 21 44.39	2.2636	33.9546	0.0016	0.0238	35 1 41.79	10.1367	0.2805	75.91
33	8.6	5	1 33.861	300 23 27.92	2.2374	33.5612	0.0016	0.0237	35 54 2.29	10.1454	0.2771	75.56
34	8.4	5	1 40.467	300 25 7.01	2.2542	33.8134	0.0016	0.0239	35 21 22.73	10.1537	0.2791	75.56
35	7.2	8	1 43.247	300 25 48.71	2.2461	33.6908	0.0016	0.0238	35 37 44.37	10.1573	0.2781	75.91
36	9.1	8	1 43.751	300 25 56.26	+2.2431	+33.6464	+0.0016	+0.0238	35 43 34.76	+10.1579	+0.2777	75.91
37	9.0	6	1 46.207	300 26 33.11	2.2357	33.5356	0.0016	0.0238	35 58 13.99	10.1610	0.2767	75.72
38	8.3	7	1 46.213	300 26 33.20	2.2233	33.3488	0.0016	0.0236	36 22 25.69	10.1610	0.2752	75.82
39	8.6	8	1 49.558	300 27 23.37	2.2389	33.5831	0.0016	0.0238	35 52 16.19	10.1651	0.2771	75.91
40	8.9	3	1 52.265	300 28 3.97	2.2497	33.7452	0.0016	0.0239	35 31 11.95	10.1686	0.2784	75.72
41	8.5	7	1 53.193	300 28 17.89	+2.2539	+33.8086	+0.0016	+0.0240	35 22 54.36	+10.1697	+0.2789	75.82
42	8.9	3	1 53.629	300 28 24.43	2.2415	33.6228	0.0016	0.0238	35 47 22.45	10.1702	0.2774	75.18
43	8.7	8	1 58.491	300 29 37.37	2.2658	33.9867	0.0016	0.0240	34 59 36.08	10.1763	0.2804	75.91
44	8.6	8	2 10.355	300 32 35.32	2.2676	34.0138	0.0016	0.0241	34 56 47.41	10.1913	0.2804	75.91
45	9.2	4	2 14.440	300 33 36.60	2.2497	33.7453	0.0016	0.0240	35 32 44.29	10.1965	0.2781	75.34
46	8.1	8	2 18.221	300 34 33.32	+2.2348	+33.5223	+0.0016	+0.0239	36 2 11.97	+10.2012	+0.2762	75.91
47	9.3	3	2 18.758	300 34 41.37	2.2570	33.8552	0.0016	0.0241	35 18 30.01	10.2018	0.2790	75.18
48	7.2	8	2 28.261	300 37 3.92	2.2219	33.3289	0.0016	0.0238	36 27 58.15	10.2138	0.2745	75.91
49	9.0	5	2 29.433	300 37 21.50	2.2669	34.0034	0.0016	0.0242	34 59 30.59	10.2153	0.2801	76.02
50	9.2	8	2 33.123	300 38 16.85	2.2365	33.5479	0.0016	0.0240	35 59 55.02	10.2199	0.2762	75.91

TABLE X.—27 CYGNI FINAL CATALOG.—*Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
51	8.9	8	20 2 33.588	300 38 23.82	+2.2604	+33.9058	+0.0016	+0.0242	35 12 49.02	+10.2205	+0.2792	1875.91
52	8.8	8	2 36.439	300 39 6.58	2.2602	33.9026	0.0016	0.0242	35 13 26.95	10.2241	0.2792	75.91
53	8.9	8	2 40.631	300 40 9.47	2.2535	33.8021	0.0016	0.0242	35 27 3.59	10.2293	0.2783	75.91
54	7.7	8	2 41.619	300 40 24.29	2.2563	33.8451	0.0016	0.0242	35 21 26.49	10.2305	0.2786	75.91
55	9.1	8	2 45.321	300 41 19.81	2.2506	33.7587	0.0016	0.0242	35 33 7.93	10.2352	0.2778	75.91
56	8.8	3	2 46.228	300 41 33.42	+2.2310	+33.4653	+0.0016	+0.0240	36 11 35.88	+10.2363	+0.2754	76.03
57	8.7	5	2 47.626	300 41 54.39	2.2307	33.4600	0.0016	0.0240	36 12 22.93	10.2380	0.2753	76.21
58	9.0	8	2 51.564	300 42 53.46	2.2597	33.8950	0.0016	0.0243	35 15 30.70	10.2430	0.2789	75.91
59	9.1	8	2 53.360	300 43 20.40	2.2532	33.7985	0.0016	0.0243	35 28 25.97	10.2452	0.2781	75.91
60	9.0	8	3 11.259	300 47 48.89	2.2399	33.5983	0.0016	0.0243	35 56 1.79	10.2677	0.2762	75.91
61	8.9	8	3 14.300	300 48 34.50	+2.2592	+33.8887	+0.0016	+0.0244	35 17 56.77	+10.2715	+0.2786	75.91
62	8.9	8	3 14.806	300 48 42.09	2.2531	33.7963	0.0016	0.0244	35 30 13.99	10.2721	0.2778	75.91
63	8.7	4	3 22.511	300 50 37.67	2.2524	33.7865	0.0016	0.0245	35 32 4.93	10.2818	0.2776	75.34
64	9.0	7	3 23.805	300 50 57.07	2.2456	33.6841	0.0016	0.0244	35 45 40.04	10.2834	0.2767	75.82
65	8.8	8	3 30.131	300 52 31.96	2.2574	33.8615	0.0016	0.0245	35 22 39.73	10.2913	0.2781	75.91
66	8.6	8	3 39.746	300 54 56.19	+2.2662	+33.9935	+0.0016	+0.0246	35 5 45.05	+10.3033	+0.2791	75.91
67	8.9	7	3 46.967	300 56 44.50	2.2474	33.7106	0.0016	0.0246	35 43 48.79	10.3124	0.2767	75.82
68	7.5	8	3 57.187	300 59 17.80	2.2301	33.4513	0.0016	0.0244	36 18 28.18	10.3252	0.2744	75.91
69	8.7	8	4 1.375	301 0 20.63	2.2352	33.5284	0.0016	0.0245	36 8 44.48	10.3304	0.2750	75.91
70	8.9	8	4 6.079	301 1 31.19	2.2464	33.6966	0.0016	0.0247	35 47 0.58	10.3363	0.2763	75.91
71	8.3	8	4 10.286	301 2 34.29	+2.2658	+33.9863	+0.0017	+0.0248	35 8 53.24	+10.3415	+0.2787	75.91
72	8.6	8	4 10.830	301 2 42.45	2.2457	33.7003	0.0016	0.0247	35 46 53.00	10.3422	0.2763	75.91
73	8.2	8	4 11.168	301 2 47.52	2.2691	34.0367	0.0017	0.0248	35 2 12.01	10.3427	0.2791	75.91
74	8.8	8	4 17.043	301 4 15.64	2.2500	33.7498	0.0017	0.0248	35 40 47.63	10.3500	0.2766	75.91
75	9.0	4	4 19.177	301 4 47.65	2.2567	33.8498	0.0017	0.0248	35 27 42.23	10.3527	0.2774	75.74

TABLE X. — 27 CYGNI FINAL CATALOG. — *Concluded.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
76	8.4	8	20 4 28.450	301 7 6.75	+2.2690	+34.0355	+0.0017	+0.0249	35 3 34.53	+10.3643	+0.2788	1875.91
77	8.9	8	4 30.408	301 7 36.12	2.2504	33.7557	0.0017	0.0248	35 40 58.41	10.3667	0.2765	75.91
78	8.7	8	4 30.469	301 7 37.03	2.2673	34.0099	0.0017	0.0249	35 7 8.53	10.3667	0.2786	75.91
79	8.0	8	4 30.883	301 7 43.25	2.2674	34.0106	0.0017	0.0249	35 7 5.28	10.3673	0.2786	75.91
80	8.2	8	4 43.661	301 10 54.92	2.2700	34.0502	0.0017	0.0250	35 2 40.70	10.3832	0.2788	75.91
81	8.5	6	4 45.905	301 11 28.57	+2.2373	+33.5598	+0.0017	+0.0248	36 7 49.53	+10.3860	+0.2746	75.83
82	7.9	8	4 46.001	301 11 30.01	2.2604	33.9067	0.0017	0.0250	35 22 2.54	10.3861	0.2775	75.91
83	8.4	7	4 46.327	301 11 34.90	2.2376	33.5637	0.0017	0.0248	36 7 20.83	10.3866	0.2747	75.82
84	8.6	7	4 56.520	301 14 7.80	2.2602	33.9036	0.0017	0.0251	35 23 13.07	10.3993	0.2774	75.82
85	8.2	8	5 6.396	301 16 35.94	2.2386	33.5788	0.0017	0.0250	36 6 49.48	10.4116	0.2746	75.91
86	8.7	8	5 14.776	301 18 41.64	+2.2686	+34.0294	+0.0017	+0.0252	35 7 42.07	+10.4220	+0.2782	75.91
87	8.1	8	5 30.539	301 22 38.09	2.2483	33.7247	0.0017	0.0252	35 49 22.69	10.4416	0.2754	75.91
88	7.9	8	5 33.059	301 23 15.88	2.2489	33.7329	0.0017	0.0252	35 48 29.42	10.4448	0.2755	75.91

TABLE I.—PHOTOGRAPHS OF 34 CYGNI.

OBSERVATORY OF L. M. RUTHERFURD, NEW YORK.

Lat. 40° 43′ 48″.5. Long. $4^h\ 55^m\ 56^s.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Zen. Dist.
				Att.	Ex.	Tel.		
		h m s	in					°
1	1875 July 19	17 5 32	30.218	68°	65°	69°	7.64	36.1
2	1875 July 19	17 33 38	30.218	68	65	69	7.64	30.8
3	1875 July 19	18 1 22	30.218	68	65	69	7.64	25.6
4	1875 Oct. 2	20 44 12	30.434	55	55	57	7.70	6.7
5	1875 Oct. 2	21 14 12	30.434	55	55	57	7.70	12.2
6	1875 Oct. 2	21 47 2	30.434	55	55	57	7.70	18.4

TABLE II.—34 CYGNI CORRECTED COÖRDINATES.

PLATE 1.						PLATE 2.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
1	−50.8481	+14.7589	54	− 2.2719	+35.9076	1	−50.8376	+14.7902
2	−50.4204	−17.8148	55	− 0.9963	−11.1176	2	−50.4284	−17.7875
3	−48.9836	+15.2035	56	− 0.4417	+38.7876	3	−48.9733	+15.2298
4	−48.5800	−28.2114	57	− 0.1430	− 6.7778	4	−48.5934	−28.1848
5	−48.4328	−12.8001	58	0.0000	0.0000	5	−48.4356	−12.7736
6	−46.8379	− 0.8617	59	+ 0.0371	+33.9571	6	−46.8418	− 0.8411
7	−45.4597	+31.5366	60	+ 0.8379	− 7.1188	7	−45.4448	+31.5592
8	−45.4871	− 0.2792	61	+ 1.2534	−14.9370	8	−45.4910	− 0.2553
9	−44.9212	−45.4828	62	+ 2.2271	−30.2223	9	−44.9454	−45.4556
10	−43.4566	−30.0506	63	+ 2.5926	−59.1282	10	−43.4684	−30.0262
11	−41.8944	+12.0676	64	+ 3.0661	+26.7128	11	−41.8892	+12.0919
12	−39.2604	+29.2978	65	+ 4.3232	+17.7733	12	−39.2536	+29.3199
13	−39.3684	−43.9183	66	+ 5.0824	+47.0255	13	−39.3860	−43.8935
14	−37.9438	+ 7.7882	67	+ 5.1719	+18.6303	14	−37.9476	+ 7.8083
15	−37.8547	+ 9.1154	68	+ 5.3240	+53.2373	15	−37.8528	+ 9.1297
16	−37.6303	−43.1424	69	+ 7.0198	+42.1172	16	−37.6541	−43.1186
17	−36.8317	−22.4216	70	+ 8.4436	−39.5192	17	−36.8474	−22.4002
18	−36.2322	+ 2.0260	71	+12.3478	+20.2369	18	−36.2350	+ 2.0457
19	−36.2134	−26.1295	72	+14.2434	−16.3733	19	−36.2247	−26.1088
20	−36.3013	−51.6042	73	+14.5550	+16.6163	20	−36.3299	−51.5816
21	−33.8070	+39.6999	74	+14.6680	−13.1124	21	−33.7950	+39.7190
22	−33.1394	−29.0759	75	+16.8267	−43.3374	22	−33.1561	−29.0565
23	−32.7674	−31.8009	77	+17.7607	−18.1275	23	−32.7850	−31.7826
24	−31.4968	−21.6759	78	+18.1141	+ 8.5656	24	−31.5102	−21.6541
25	−31.3870	−47.0923	79	+19.2224	−25.5230	25	−31.4180	−47.0737
26	−30.5242	+13.1989	81	+21.2032	+25.5146	26	−30.5216	+13.2156
28	−27.0025	+16.2030	82	+21.8025	+ 9.6681	27	−27.5922	− 1.6044
29	−26.9946	− 3.5511	83	+23.8436	+31.0384	28	−26.9935	+16.2213
30	−23.1837	−27.0532	84	+23.8514	+47.2944	29	−26.9962	− 3.5354
31	−22.5828	−32.1035	85	+25.0528	+20.3588	30	−23.2012	−27.0412
32	−19.3320	−39.7702	86	+25.5868	−21.4685	31	−22.6024	−32.0901
33	−17.7039	−26.2816	87	+25.6069	+10.0912	32	−19.3482	−39.7602
34	−17.5407	− 7.2688	89	+26.9378	−19.6615	33	−17.7204	−26.2758
35	−17.3952	−10.6132	90	+27.0829	+38.0274	34	−17.5496	− 7.2600
37	−17.3620	−26.3659	91	+27.3718	+20.8119	35	−17.4112	−10.6013
38	−17.1156	−26.1579	92	+28.5519	−42.6499	36	−17.3904	−24.6330
39	−16.5246	−44.8220	93	+31.5602	−14.0400	37	−17.3778	−26.3558
40	−16.1098	−23.3291	95	+32.2575	+54.1586	38	−17.1348	−26.1514
41	−15.6137	− 3.5848	96	+34.1534	− 6.1214	39	−16.5532	−44.8143
42	−15.3646	−39.5955	97	+35.0767	+31.1997	40	−16.1290	−23.3212
43	−15.2041	−33.7450	98	+40.8530	−40.2056	41	−15.6142	− 3.5809
44	−12.7363	−34.8872	99	+40.4839	+14.8470	42	−15.3856	−39.5883
45	−11.9350	−56.5486	100	+41.9294	−20.8205	43	−15.2251	−33.7318
46	−11.1482	−23.7767	102	+42.7948	+35.7858	44	−12.7555	−34.8810
47	−11.1509	−41.3428	103	+46.3242	+20.6167	45	−11.9645	−56.5428
48	−10.3286	+ 6.0730	104	+48.1096	−12.1290	46	−11.1642	−23.7702
50	− 5.2786	+13.8564	107	+53.6276	+18.1447	47	−11.1728	−41.3365
51	− 4.5712	−49.2338	108	+54.4720	+40.1984	48	−10.3246	+ 6.0752
52	− 4.2040	−28.3610	109	+59.5412	+ 3.9904	49	− 7.5598	+ 3.4466
53	− 3.0996	+23.2716				50	− 5.2754	+13.8614

TABLE II.—34 CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 2.			PLATE 2.			PLATE 3.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
51	— 4.6006	—49.2347	100	+41.9218	—20.8416	39	—16.5396	—44.8091
52	— 4.2208	—28.3578	101	+42.1946	+ 2.0467	40	—16.1216	—23.3182
53	— 3.0886	+23.2766	102	+42.8162	+35.7693	42	—15.3754	—39.5813
54	— 2.2592	+35.9117	103	+46.3296	+20.5957	43	—15.2159	—33.7296
55	— 1.0058	—11.1167	104	+48.1125	—12.1540	44	—12.7482	—34.8734
56	— 0.4299	+38.7882	105	+49.4177	—18.9476	45	—11.9547	—56.5317
57	— 0.1520	— 6.7777	106	+49.1094	+20.1608	46	—11.1612	—23.7641
58	0.0000	0.0000	107	+53.6388	+18.1210	47	—11.1632	—41.3312
59	+ 0.0509	+33.9585	108	+54.4872	+40.1713	48	—10.3214	+ 6.0798
60	+ 0.8364	— 7.1159	109	+59.5443	+ 3.9630	49	— 7.5725	+ 3.4516
61	+ 1.2390	—14.9396				50	— 5.2756	+13.8675
62	+ 2.2092	—30.2204	PLATE 3			51	— 4.5925	—49.2298
63	+ 2.5513	—59.1280				52	— 4.2138	—28.3532
64	+ 3.0731	+26.7094	1	—50.8408	+14.7919	53	— 3.0894	+23.2837
65	+ 4.3288	+17.7710	2	—50.4240	—17.7848	54	— 2.2619	+35.9151
66	+ 5.1027	+47.0225	4	—48.5862	—28.1788	55	— 1.0006	—11.1092
67	+ 5.1777	+18.6306	5	—48.4372	—12.7684	56	— 0.4355	+38.7923
68	+ 5.3457	+53.2361	6	—46.8390	— 0.8394	57	— 0.1471	— 6.7715
69	+ 7.0372	+42.1164	7	—45.4470	+31.5598	58	0.0000	0.0000
70	+ 8.4192	—39.5197	8	—45.4872	— 0.2557	59	+ 0.0488	+33.9626
71	+12.3512	+20.2270	9	—44.9381	—45.4506	60	+ 0.8460	— 7.1100
72	+14.2314	—16.3785	10	—43 4642	—30.0214	61	+ 1.2475	—14.9327
73	+14.5604	+16.6087	11	—41.8914	+12.0918	62	+ 2.2139	—30.2149
74	+14.6589	—13.1175	12	—39.2531	+29.3238	64	+ 3.0721	+26.7143
75	+16.8052	—43.3412	13	—39.3777	—43.8932	65	+ 4.3338	+17.7774
76	+17.4580	+14.8462	14	—37.9482	+ 7.8104	66	+ 5.0998	+47.0293
77	+17.7492	—18.1310	16	—37.6472	—43.1191	67	+ 5.1813	+18.6350
78	+18.1166	+ 8.5578	17	—36.8414	—22.3988	68	+ 5.3418	+53.2384
79	+19.2086	—25.5315	18	—36.2278	+ 2.0489	69	+ 7.0316	+42.1246
80	+21.0895	—25.8792	19	36.2221	—26.1049	70	+ 8.4291	—39.5160
81	+21.2092	+25.5144	20	—36.3160	—51.5795	71	+12.3522	+20.2375
82	+21.8064	+ 9.6583	21	—33.7991	+39.7196	72	+14.2392	—16.3695
83	+23.8570	+31.0288	22	—33.1490	—29.0528	73	+14.5597	+16.6164
84	+23.8756	+47.2860	23	—32.7727	—31.7818	74	+14.6627	—13.1090
85	+25.0593	+20.3460	24	—31.5026	—21.6518	75	+16.8116	—43.3385
86	+25.5759	21.4843	25	—31.4064	—47.0676	76	+17.4610	+14.8556
87	+25.6182	+10.0795	26	—30.5198	+13.2226	77	+17.7546	—18.1259
88	+26.5329	—61.5492	27	—27.5915	— 1.5994	78	+18.1160	+ 8.5691
89	+26.9298	—19.6744	28	—26.9973	+16.2276	79	+19.2146	—25.5195
90	+27.0932	+38.0192	29	—26.9951	— 3.5296	80	+21.0982	—25.8724
91	+27.3776	+20.7978	30	—23.1972	—27.0398	81	+21.2110	+25.5233
92	+28.5290	—42.6614	31	—22.5966	—32.0894	82	+21.8122	+ 9.6646
93	+31.5480	—14.0525	32	—19.3418	—39.7540	83	+23.8546	+31.0354
94	+32.0574	+42.2766	33	—17.7117	—26.2683	84	+23.8681	+47.2948
95	+32.2780	+54.1426	34	—17.5460	— 7.2567	85	+25.0588	+20.3582
96	+34.1484	— 6.1362	35	—17.4071	—10.5943	86	+25.5795	—21.4739
97	+35.0851	+31.1858	36	—17.3827	—24.6270	87	+25.6140	+10.0857
98	+40.8297	—40.2254	37	—17.3729	—26.3492	89	+26.9340	—19.6644
99	+40.4881	+14.8286	38	—17.1269	—26.1459	91	+27.3782	+20.8076

TABLE II.—34 CYGNI, CORRECTED COÖRDINATES.—*Continued.*

PLATE 3.

Star.	*X*	*Y*
92	+28.5387	−42.6509
93	+31.5533	−14.0465
94	+32.0571	+42.2889
95	+32.2756	+54.1547
96	+34.1568	− 6.1286
97	+35.0873	+31.1945
98	+40.8416	−40.2103
99	+40.4880	+14.8402
100	+41.9290	−20.8318
101	+42.1929	+ 2.0604
102	+42.8103	+35.7796
103	+46.3295	+20.6073
104	+48.1152	−12.1420
105	+49.4245	−18.9396
106	+49.1125	+20.1748
107	+53.6363	+18.1338
108	+54.4909	+40.1814
109	+59.5493	+ 3.9765

PLATE 4.

Star.	*X*	*Y*
1	−50.8362	+14.7800
2	−50.4087	−17.7984
3	−48.9730	+15.2216
4	−48.5661	−28.1884
5	−48.4218	−12.7804
6	−46.8300	− 0.8501
7	−45.4482	+31.5546
8	−45.4817	− 0.2581
9	−44.9213	−45.4716
10	−43.4457	−30.0356
11	−41.8853	+12.0824
12	−39.2539	+29.3081
13	−39.3485	−43.9010
14	−37.9360	+ 7.8010
15	−37.8458	+ 9.1207
16	−37.6275	−43.1293
17	−36.8292	−22.4089
18	−36.2214	+ 2.0392
19	−36.1974	−26.1180
20	−36.2880	−51.5908
21	−33.8008	+39.7179
22	−33.1287	−29.0606
23	−32.7548	−31.7870
24	−31.4858	−21.6553
26	−30.5148	+13.2110
27	−27.5784	− 1.6088
28	−26.9928	+16.2186
29	−26.9816	− 3.5380
30	−23.1744	− 27.0481
31	−22.5741	−32.0944
32	−19.3147	−39.7603
33	−17.6921	−26.2718
34	−17.5309	− 7.2611
35	−17.3864	−10.6032
36	−17.3607	24.6333
37	−17.3486	−26.3536
38	−17.1043	−26.1517
39	−16.5127	−44.8171
40	−16.1005	−23.3230
41	−15.6004	− 3.5768
42	−15.3524	−39.5910
43	−15.1942	−33.7359
44	−12.7230	−34.8810
45	−11.9220	−59.5400
46	−11.1398	−23.7682
47	−11.1360	−41.3376
48	−10.3128	+ 6.0772
49	− 7.5510	+ 3.4487
50	− 5.2680	+13.8622
51	− 4.5598	−49.2321
52	− 4.1931	−28.3555
54	− 2.2610	+35.9178
55	− 0.9860	−11.1119
56	− 0.4318	+38.7952
57	− 0.1302	− 6.7756
58	0.0000	0.0000
59	+ 0.0496	+33.9638
60	+ 0.8582	− 7.1120
61	+ 1.2716	−14.9324
62	+ 2.2384	−30.2146
63	+ 2.6050	−59.1216
64	+ 3.0765	+26.7159
65	+ 4.3404	+17.7780
66	+ 5.0950	+47.0347
67	+ 5.1924	+18.6357
68	+ 5.3376	+53.2457
69	+ 7.0319	+42.1290
70	+ 8.4586	−39.5145
71	+12.3604	+20.2393
72	+14.2548	−16.3694
73	+14.5712	+16.6219
74	+14.6845	−13.1083
76	+17.4688	+14.8578
77	+17.7747	−18.1238
78	+18.1285	+ 8.5702
79	+19.2405	−25.5186
80	+21.1225	−25.8689
81	+21.2172	+25.5262
82	+21.8219	+ 9.6690
83	+23.8548	+31.0460
84	+23.8641	+47.2953
85	+25.0665	+20.3624
86	+25.6028	−21.4708
87	+25.6282	+10.0928
88	+26.5805	−61.5509
89	+26.9548	−19.6651
90	+27.0964	+38.0345
91	+27.3833	+20.8098
92	+28.5664	−42.6471
93	+31.5739	−14.0382
94	+32.0586	+42.2984
95	+32.2655	+54.1598
96	+34.1739	− 6.1231
97	+35.0880	+31.2047
98	+40.8728	−40.2063
99	+40.4990	+14.8439
100	+41.9520	−20.8262
101	+42.2127	+ 2.0669
102	+42.8101	+35.7905
103	+46.3398	+20.6164
104	+48.1403	−12.1324
105	+49.4561	−18.9298
106	+49.1178	+20.1838
107	+53.6518	+18.1442
109	+59.5646	+ 3.9874

PLATE 5.

Star.	*X*	*Y*
1	− 50.8418	+14.7782
2	−50.4107	−17.7981
3	−48.9752	+15.2186
4	−48.5773	−28.1914
5	−48.4319	−12.7824
6	−46.8348	− 0.8539
7	−45.4446	+31.5473
8	−45.4848	− 0.2646
9	−44.9267	−45.4719
10	−43.4528	−30.0299
11	−41.8848	+12.0817
12	−39.2565	+29.3105
13	−39.3586	−43.9043
14	−37.9364	+ 7.8017
16	−37.6286	−43.1315
17	−37.8292	−22.4096
18	−36.2242	+ 2.0421
19	−36.2058	−26.1129

Table II.—34 Cygni Corrected Coördinates.—*Concluded.*

Plate 5.			Plate 5.			Plate 6.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
20	—36.2937	—51.5907	88	+26.5724	—61.5416	42	—15.3648	—39.5889
21	—33.7984	+39.7184	91	+27.3831	+20.8135	43	—15.2014	—33.7322
22	—33.1328	—29.0600	92	+28.5604	—42.6457	44	—12.7321	—34.8741
26	—30.5131	+13.2131	93	+31.5718	—14.0380	45	—11.9428	—56.5381
29	—26.9838	— 3.5381	95	+32.2782	+54.1631	46	—11.1421	—23.7683
30	—23.1800	—27.0458	98	+40.8640	—40.2050	47	—11.1498	—41.3339
32	—19.3220	—39.7601	99	+40.4996	+14.8437	50	— 5.2594	+13.8645
33	—17.6933	—26.2718	100	+41.9500	—20.8256	51	— 4.5740	—49.2289
34	—17.5374	— 7.2600	102	+42.8196	+35.7894	52	— 4.1981	—28.3531
37	—17.3526	—26.3561	103	+46.3416	+20.6160	54	— 2.2458	+35.9175
38	—17.1106	—26.1500	107	+53.6510	+18.1450	56	— 0.4190	+38.7984
39	—16.5198	—44.8152	109	+59.5615	+ 3.9937	57	— 0.1299	— 6.7707
40	—16.1037	—23.3202				58	0.0000	0.0000
42	—15.3608	—39.5877	Plate 6.			59	+ 0.0636	+33.9656
43	—15.1977	—33.7332				63	+ 2.5918	—59.1206
44	—12.7325	—34.8790	1	—50.8281	+14.7805	64	+ 3.0890	+26.7185
45	—11.9321	—56.5400	2	—50.4173	—17.7969	65	+ 4.3494	+17.7816
46	—11.1414	—23.7679	3	—48.9633	+15.2218	66	+ 5.1150	+47.0335
47	—11.1447	—41.3370	4	—48.5760	—28.1882	69	+ 7.0479	+42.1324
50	— 5.2688	+13.8632	6	—46.8284	— 0.8501	70	+ 8.4426	—39.5112
51	— 4.5702	—49.2336	7	—45.4331	+31.5488	71	+12.3691	+20.2402
52	— 4.1995	—28.3527	9	—44.9327	—45.4672	72	+14.2593	—16.3654
54	— 2.2612	+35.9184	10	—43.4514	—30.0291	73	+14.5743	+16.6240
56	— 0.4341	+38.7956	11	—41.8794	+12.0839	74	+14.6815	—13.1059
57	— 0.1324	— 6.7741	13	—39.3628	—43.8974	77	+17.7756	—18.1216
58	0.0000	0.0000	14	—37.9341	+ 7.8074	79	+19.2352	—25.5186
59	+ 0.0543	+33.9652	16	—37.6365	—43.1269	82	+21.8232	+ 9.6705
63	+ 2.5948	—59.1236	17	—36.8280	—22.4084	84	+23.8814	+47.3022
64	+ 3.0814	+26.7124	18	—36.2174	+ 2.0420	85	+25.0716	+29.3638
66	+ 5.0971	+47.0365	20	—36.3012	—51.5913	86	+25.6004	—21.4661
69	+ 7.0302	+42.1286	21	—33.7858	+39.7226	87	+25.6328	+10.0950
70	+ 8.4440	—39.5098	22	—33.1304	—29.0595	88	+26.5643	—61.5405
71	+12.3621	+20.2378	23	—32.7572	—31.7837	89	+26.9540	—19.6569
72	+14.2506	—16.3706	26	—30.5044	+13.2146	91	+27.3930	+20.8137
73	+14.5696	+16.6227	30	—23.1788	—27.0418	92	+28.5568	—42.6480
74	+14.6794	—13.1070	32	—19.3288	—39.7583	93	+31.5774	—14.0371
77	+17.7742	—18.1236	33	—17.6965	—26.2680	95	+32.2873	+54.1658
78	+18.1277	+ 8.5694	34	—17.5293	— 7.2575	99	+40.5055	+14.8429
79	+19.2301	—25.5183	35	—17.3856	—10.6017	100	+41.9519	—20.8201
84	+23.8707	+47.3041	37	—17.3540	—26.3523	102	+42.8295	+35.7900
85	+25.0686	+20.3627	38	—17.1088	—26.1490	103	+46.3512	+20.6186
86	+25.5968	—21.4693	39	—16.5268	—44.8113	107	+53.6586	+18.1456
87	+25.6155	+10.0984	40	—16.1074	—23.3192	108	+54.5176	+40.2038

TABLE III.—34 CYGNI REFRACTION COEFFICIENTS.

Plate.	M_x	N_x	M_y	N_y
1	+0.000411	+0.000100	−0.000195	+0.000297
2	+ .000370	+ .000093	− .000152	+ .000290
3	+ .000339	+ .000081	− .000117	+ .000286
4	+ .000291	− .000021	+ .000025	+ .000289
5	+ .000300	− .000041	+ .000050	+ .000290
6	+ .000317	− .000062	+ .000080	+ .000291

TABLE IV.—34 CYGNI PLATE CONSTANTS.

Plate.	*p*	*r*	Probable Error of *p* or *r*.	*k*	*c*	Probable Error of *k* or *c*.	Probable Error of One Equation.
1	−0.000002	+0.000108	±0.000005	+0″.311	+0″.273	±0″.010	±0″.0792
2	+ .000017	− .000357	.000004	+ .450	+ .209	.009	.0682
3	+ .000043	− .000200	.000004	+ .324	− .131	.008	.0616
4	+ .000014	+ .000206	.000006	− .368	− .078	.013	.1005
5	− .000016	+ .000170	.000004	− .243	− .102	.010	.0759
6	− .000056	+ .000074	.000007	− .477	− .172	.016	.1234

TABLE V.—34 CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.

Star.	X_m	1	2	3	4	5	6	Star.	X_m	1	2	3	4	5	6
	″	″	″	″	″	″	″		″	″	″	″	″	″	″
1	−2688.73	−.23	+.16	−.02	−.02	−.19	+.28	51	−242.19	+.18	.00	−.08	+.18	−.08	−.22
2	−2666.54	−.16	+.05	+.04	+.07	+.21	−.20	52	−222.42	+.06	+.03	+.05	+.02	−.11	−.08
3	−2590.11	−.23	+.13		−.10	−.09	+.27	53	−163.28	−.10	+.06	+.05			
4	−2569.32	−.16	+.04	+.09	+.20	−.12	−.05	54	−119.49	+.03	−.04	−.05	−.10	−.10	+.26
5	−2561.42	−.10	+.27	−.03	+.08	−.23		55	−52.56	+.06	−.03	+.03	−.07		
6	−2477.02	−.01	−.01	+.03	−.01	−.09	+.08	56	−22.80	+.18	−.03	−.15	−.02	−.14	−.18
7	−2403.51	−.26	−.08	−.05	−.14	+.14	+.38	57	−7.36	+.03	−.13	−.05	+.05	+.07	+.01
8	−2405.62	+.05	+.03	+.11	−.10	−.08		58	0.00	+.31	+.45	+.32	−.37	−.24	−.4
9	−2376.36	+.22	+.27	+.18	−.16	−.13	−.35	59	+2.73	−.08	−.06	−.04	−.15	+.13	−.1
10	−2298.36	−.15	+.17	+.04	+.02	−.09	−.02	60	+44.85	−.30	−.06	+.26	+.09		
11	−2215.32	−.11	+.06	−.08	−.08	+.08	+.11	61	+66.44	+.01	−.24	−.04	+.29		
12	−2076.03	+.11	−.07	+.07	−.03	−.09		62	+117.70	+.08	+.02	−.10	+.01		
13	−2082.10	−.34	+.01	.00	+.31	+.09	−.06	63	+136.59	+.20	−.37		+.23	.00	−.0
14	−2006.61	+.10	−.11	−.20	+.03	+.15	+.03	64	+162.74	+.04	−.13	−.10	−.14	+.15	−.16
15	−2001.77	−.02	+.04		−.03			65	+229.33	−.16	−.18	+.10	+.02		+.21
16	−1990.62	+.13	+.13	+.05	−.14	+.09	−.24	66	+269.72	−.07	−.04	+.04	−.17	−.08	+.34
17	−1948.13	+.11	+.02	+.05	−.22	+.03	+.02	67	+274.19	−.13	−.15	+.05	+.22		
18	−1915.93	−.12	−.13	+.15	−.03	.00	+.14	68	+282.48	+.02	−.03	+.04	−.04		
19	−1915.19	−.17	+.06	−.12	+.22	+.03		69	+372.02	+.04	+.05	−.06	−.08	−.18	−.25
20	−1920.16	−.13	−.17	+.05	+.15	+.16	−.09	70	+446.29	+.17	.00	+.10	+.30	−.24	−.3
21	−1787.44	+.08	−.09	−.13	−.13	+.03	+.26	71	+653.57	+.07	−.14	−.06	−.05	+.10	−.0
22	−1752.71	−.09	−.07	−.03	+.01	+.03	+.16	72	+753.44	+.04	−.06	+.11	−.09	−.14	+.16
23	−1732.98	−.18	−.14	+.15	+.02		+.16	73	+770.33	.00	−.01	−.05	+.07	+.04	−.0
24	−1665.78	−.07	−.05	+.06	+.04			74	+775.98	+.01	−.02	−.06	+.13	+.01	−.0
25	−1660.46	+.14	−.14	−.01				75	+889.82	.00	+.06	−.06			
26	−1613.92	−.09	−.13	−.04	−.13	+.08	+.26	76	+923.66		−.06	+.08	−.02		
27	−1458.93		+.04	−.06	+.03			77	+939.52	−.02	−.05	−.03	−.03	+.10	+.0
28	−1427.66	−.05	+.18	−.02	−.10			78	+958.48	.00	+.04	−.05	−.03	+.02	
29	−1427.39	−.12	+.05	−.05	+.03	+.09		79	+1016.75	−.01	+.01	.00	+.20	−.18	−.01
30	−1226.29	+.09	.00	−.12	+.05	−.02	+.02	80	+1116.36		−.12	+.01	+.11		
31	−1194.54	+.06	−.01	−.08	+.01			81	+1121.98	+.08	−.13	+.04	−.01		
32	−1022.44	−.18	+.10	+.02	+.20	+.09	−.24	82	+1153.72	−.13	−.05	+.19	+.07		−.1
33	−936.31	−.06	−.12	+.02	+.02	+.19	−.04	83	+1261.73	+.05	+.10	+.06	−.22		
34	−927.61	+.08	−.05	−.03	+.03	−.14	+.12	84	+1262.52	−.05	+.16	.00	−.25	+.06	−.0
35	−920.06	+.19	−.23	−.21	+.09		+.15	85	+1325.56	+.06	+.01	+.01	−.05	+.10	−.1
36	−918.88		−.12	−.02	+.13			86	+1353.39	+.02	+.08	−.02	+.06	−.09	−.0
37	−918.24	−.05	−.06	−.13	+.11	+.13	.00	87	+1354.96	−.14	+.30	+.03	+.14	−.46	+.1
38	−905.31	+.06	−.15	−.05	+.12	.00	+.04	88	+1404.58		+.06		+.19	+.04	−.2
39	−874.27	+.07	−.16	+.09	+.17	+.08	−.23	89	+1424.96	−.09	+.09	+.02	+.01		−.0
40	−852.16	+.14	−.14	−.05	+.08	+.11	−.15	90	+1433.04	+.15	−.15		−.01		
41	−825.45	−.12	+.11		+.01			91	+1448.16	+.12	+.01	+.08	−.12	−.12	+.0
42	−812.80	+.02	+.05	+.16	+.11	−.06	−.26	92	+1509.92	+.07	+.04	+.09	+.07	−.04	−.2
43	−804.28	+.05	−.07	+.06	+.02	+.08	−.12	93	+1669.34	+.10	−.11	−.07	−.02	−.01	+.1
44	−673.73	+.01	+.03	+.01	+.14	−.10	−.09	94	+1695.48		−.09	+.08	+.02		
45	−631.65	+.08	+.09	+.05	+.22	−.01	−.44	95	+1706.96	+.10	−.06	+.09	−.40	+.20	−.0
46	−589.70	+.10	.00	−.14	−.04	+.07	−.03	96	+1806.79	−.12	−.12	+.13	+.10		
47	−589.91	−.02	.00	+.07	+.20	−.01	−.24	97	+1855.78	+.14	−.10	+.12	−.17		
48	−545.74	−.17	+.04	+.12	+.02			98	+2160.66	−.01	−.14	+.03	+.18	−.08	
49	−399.78		+.34	−.43	+.10			99	+2141.66	+.07	+.02	−.01	−.06	+.02	−.0
50	−278.75	+.02	.00	−.03	−.09	−.04	+.14	100	+2218.04	−.24	−.03	+.05	+.06	+.11	+.0

TABLE V. 34 CYGNI MEAN *Y* AND RESIDUALS FOR EACH PLATE.

ar.	Y_m	1	2	3	4	5	6	Star.	Y_m	1	2	3	4	5	6
	″	″	″	″	″	″	″		″	″	″	″	″	′	″
1	+ 781.78	—.17	+.08	+.16	+.29	—.02	—.33	51	—2603.64	+.23	—.03	—.14	—.08	—.12	+.12
2	— 941.05	—.02	.00	+.11	+.17	+.03	—.27	52	—1499.58	+.02	+.01	—.09	—.07	+.09	+.02
3	+ 805.09	+.01	+.04		+.31	—.05	—.31	53	+1231.17	—.12	+.02	+.11			
4	—1490.73	—.20	—.17	+.08	+.35	+.05	—.12	54	+1899.36	—.07	+.06	—.05	+.13	+.08	—.13
5	— 675.74	—.15	—.12	+.11	+.22	—.05		55	— 587.70	+.03	—.02	+.04	—.04		
6	— 44.79	+.24	+.01	+.06	+.21	—.17	—.35	56	+2051.57	+.01	—.01	—.08	+.07	+.01	+.01
7	+1668.72	+.12	+.04	+.07	+.43	—.17	—.52	57	— 358.28	+.10	+.04	+.01	—.13	—.06	+.06
8	— 13.70	—.06	—.08	—.15	+.41	—.10		58	0.00	+.27	+.21	—.13	—.08	—.10	—.17
9	—2404.40	.00	+.14	+.31	—.05	—.18	—.20	59	+1796.10	+.01	+.05	—.04	+.04	+.03	—.09
10	—1588.14	—.14	—.10	+.07	+.02	+.20	—.05	60	— 376.18	—.04	+.06	+.02	—.03		
11	+ 639.14	.00	+.12	+.04	+.17	—.04	—.30	61	— 789.82	+.12	—.06	—.05	+.01		
12	+1550.36	—.03	+.04	+.20	—.07	—.14		62	—1598.06	—.03	+.05	—.05	+.03		
13	—2321.63	—.11	+.06	—.06	+.18	—.07	+.03	63	—3126.78	—.02	—.04		—.03	—.06	+.17
14	+ 412.76	.00	—.02	+.02	+.09	—.03	—.07	64	+1412.77	+.18	+.04	—.04	+.02	—.22	.00
15	+ 482.74	+.21	—.10		—.10			65	+ 940.12	+.03	—.02	—.03	—.04		+.04
16	—2280.74	.00	+.16	—.02	+.08	—.11	—.10	66	+2487.20	—.03	—.09	—.05	+.15	+.16	—.13
17	—1184.95	+.04	+.10	+.05	+.11	—.04	—.24	67	+ 985.48	—.02	+.09	—.04	—.04		
18	+ 108.02	—.03	—.01	+.05	+.09	+.10	—.22	68	+2815.68	—.01	+.04	—.15	+.14		
19	—1380.95	—.08	—.02	+.04	—.06	+.11		69	+2227.76	—.20	—.10	+.01	+.13	+.05	+.14
20	—2728.24	—.02	+.10	+.04	+.07	+.02	—.21	70	—2089.79	—.07	+.04	—.20	—.13	+.18	+.17
21	+2100.50	—.14	—.08	—.11	+.28	+.10	—.06	71	+1070.18	+.13	—.11	+.06	.00	—.10	.00
22	—1536.80	—.10	—.04	.00	+.15	+.08	—.13	72	— 865.83	—.05	.00	+.01	—.10	—.10	+.22
23	—1681.00	—.02	—.02	—.12	+.14		+.03	73	+ 878.82	—.02	—.09	—.09	+.02	+.06	+.13
24	—1145.33	—.24	.00	—.05	+.28			74	— 693.37	—.05	+.01	+.01	—.10	+.02	+.13
25	—2489.65	—.08	—.03	+.10				75	—2291.94	+.01	+.18	—.18			
26	+ 698.84	—.04	—.03	+.21	+.05	+.02	—.20	76	+ 785.57		—.01	+.06	—.05		
27	— 84.90		—.04	+.06	—.01			77	— 958.62	—.07	+.14	—.06	—.14	—.05	+.14
28	+ 857.82	—.22	—.02	+.16	+.10			78	+ 453.02	—.05	—.02	+.13	—.02	—.06	
29	— 187.01	—.10	—.05	+.09	+.08	—.03		79	—1349.77	—.06	—.07	+.06	—.07	+.03	+.12
30	—1430.22	+.15	+.08	—.08	—.09	—.03	.00	80	—1368.32		+.11	—.04	—.06		
31	—1697.22	+.04	+.07	—.14	+.02			81	+1349.65	—.36	+.15	+.17	+.05		
32	—2102.70	+.02	—.06	.00	+.03	+.02	+.01	82	+ 511.17	+.05	+.07	—.06	—.11		+.07
33	—1389.40	+.04	—.21	—.08	+.09	+.04	+.12	83	+1641.44	—.07	+.02	—.09	+.15		
34	— 383.93	+.07	—.01	—.06	+.02	—.01	—.03	84	+2501.21	—.14	+.04	+.07	—.26	+.19	+.08
35	— 560.68	—.06	+.04	+.17	+.01		—.14	85	+1076.60	—.04	—.10	+.07	—.04	+.02	+.12
36	—1302.69		—.04	+.02	+.03			86	—1135.63	+.12	—.11	—.09	—.20	—.02	+.29
37	—1393.77	—.06	—.06	+.03	+.13	—.05	+.01	87	+ 533.56	—.01	—.02	—.18	—.12	+.22	+.13
38	—1382.96	+.13	—.06	—.03	—.01	+.03	—.04	88	—3254.89		.+28		—.63	+.03	+.32
39	—2370.00	+.10	—.03	—.05	—.11	—03.	+.10	89	—1040.00	+.03	—.01	—.01	—.35		+.34
40	—1233.34	+.10	+.01	—.09	—.05	+.06	—.02	90	+2011.10	—.16	+.10		+.05		
41	— 189.17	+.10	—.17		+.07			91	+1100.42	+.07	.00	+.02	—.21	+.01	+.10
42	—2093.62	+.11	—.02	+.08	—.12	+.04	—.12	92	—2255.66	—.09	—.02	—.04	—.12	+.09	+.16
43	—1784.03	—.08	+.12	—.04	—.07	+.06	+.02	93	— 742.71	—.04	+.07	—.17	—.09	+.01	+.23
44	—1844.57	+.01	—.08	+.02	—.10	.00	+.17	94	+2236.53		—.12	+.03	+.08		
45	—2990.12	—.02	—.14	+.12	—.02	.00	+.07	95	+2864.05	—.08	—.09	+.06	—.14	+.03	+.21
46	—1257.01	+.02	—.01	+.01	+.05	+.03	—.10	96	— 324.08	+.06	+.14	—.03	—.16		
47	—2186.06	+.07	+.02	—.01	—.09	—.06	+.04	97	+1649.82	—.09	+.07	—.01	+.05		
48	+ 321.45	+.16	—.05	—.08	—.03			98	—2126.67	—.01	—.05	+.10	—.15	+.09	
49	+ 182.39		+.02	.00	—.01			99	+ 784.76	+.05	+.12	+.14	—.19	—.11	+.01
50	+ 733.14	+.02	+.08	+.11	—.06	—.06	—.12	100	—1101.59	+.08	+.01	—.10	—.30	—.13	+.42

TABLE V.—34 CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.—*Continued.*

Star.	X_m	1	2	3	4	5	6	Star.	X_m	1	2	3	4	5	6
	″	″	″	″	″	″	″		″	″	″	″	″	″	″
101	+2232.04		+.07	−.14	+.08			106	+2597.61		−.03	+.15	−.13		
102	+2264.36	−.17	+.16	−.02	−.32	+.15	+.18	107	+2837.14	−.17	+.03	−.10	+.11	+.08	+.0
103	+2450.64	+.06	−.08	−.07	−.07	+.04	+.13	108	+2882.09	−.23	−.35	+.01			+.5
104	+2545.19	−.42	+.12	+.03	+.28			109	+3149.73	−.15	−.01	+.13	+.08	−.03	
105	+2614.64		−.21	−.13	+.34										

TABLE V. — 34 CYGNI MEAN *Y* AND RESIDUALS FOR EACH PLATE. — *Continued.*

ar.	Y_m	1	2	3	4	5	6	Star.	Y_m	1	2	3	4	5	6
	″	″	″	″	″	″	′		″	″	″	″	″	″	″
1	+ 108.92		—.01	+.11	—.09			106	+1066.98		—.01	+.10	—.09		
2	+1892.34	—.20	+.04	+.01	—.01	—.01	+.17	107	+ 959.14	—.14	+.01	+.01	—.16	+.01	+.30
3	+1089.94	—.09	.00	.00	—.14	—.06	+.28	108	+2125.44	—.12	—.13	—.24			+.48
4	— 642.06	+.11	+.01	—.02	—.11			109	+ 210.44	—.09	.00	.00	—.22	+.29	
5	—1001.52		+.20	—.06	—.15										

TABLE VI. — 34 CYGNI CONCORDANCE WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.
1	9144	38	9192	63	9223	90	9266
2	9148	39	9193	64	9225	91	9267
5	9150	42	9194	66	9229	92	9269
7	9156	43	9195	68	9230	93	9273
9	9159	44	9198	69	9232	95	9274
10	9160	45	9200	73	9247	98	9281
12	9166	46	9202	74	9248	99	9282
14	9168	47	9203	75	9252	100	9284
16	9169	50	9209	77	9254	102	9286
17	9170	51	9210	78	9255	103	9292
20	9171	52	9211	79	9256	107	9300
21	9172	56	9216	84	9260	108	9303
24	9175	58	9217	85	9263	109	9308
34	9187	59	9218	86	9264		
37	9189	62	9221	88	9265		

TABLE VII.—34 CYGNI COMPARISON WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

$p = +0.000440 \quad \pm 0.000020$
$r = +0.000074 \quad \pm 0.000020$
$k = +0''.675 \quad \pm 0''.048$
$c = +0''.077 \quad \pm 0''.048$
Probable error of a single equation = ± 0.3636

RESIDUALS.

Star.	v_x	v_y	Star.	v_x	v_y
	″	″		″	″
1	—0.02	—0.43	62	—0.45	+0.41
2	—0.50	+0.05	63	+0.24	+0.52
5	—1.10	—0.14	64	—0.28	—0.32
7	+0.30	—0.52	66	—0.05	—0.21
9	+0.03	+0.40	68	+0.38	—0.05
10	—0.30	—0.08	69	—0.81	+0.74
12	—0.16	—0.14	73	+0.27	+0.50
14	—0.67	—0.99	74	+0.55	—0.67
16	+0.17	+0.53	75	—0.52	+0.01
17	—0.42	+0.36	77	—0.06	+0.33
20	—0.23	+0.43	78	—0.35	+0.09
21	+0.27	—0.24	79	+0.13	—0.35
24	+0.34	—0.76	84	+0.02	+0.21
34	+0.02	—0.66	85	—0.72	—1.58
37	+0.52	—0.47	86	—0.78	+0.36
38	+0.18	+0.39	88	+0.74	—0.55
39	—0.74	—0.39	90	+0.12	—0.54
42	—0.57	+0.16	91	+0.56	+0.40
43	+0.22	+0.18	92	—0.37	+0.02
44	—0.31	—0.03	93	+0.25	—0.56
45	+0.50	+1.48	95	+0.93	—0.14
46	+0.47	+0.53	98	—0.91	+0.02
47	+0.44	+0.84	99	+0.95	—0.03
50	+1.15	—0.09	100	+0.52	—0.46
51	—0.64	—0.66	102	—0.61	+0.64
52	+0.91	+0.28	103	—0.37	—0.67
56	—0.06	—0.02	107	+0.22	+0.72
58	+0.68	+0.08	108	—0.29	+1.18
59	—0.59	—0.08	109	+0.77	—0.03

TABLE VIII.—34 CYGNI FINAL COÖRDINATES.

Star.	*X*	*Y*	Star.	*X*	*Y*
1	−2689″.17	+ 782″.40	51	− 241″.81	−2604″.69
2	−2667.10	− 941.18	52	− 221.95	−1500.14
3	−2590.51	+ 805.71	53	− 162.58	+1231.80
4	−2569.88	−1491.12	54	− 118.72	+1900.29
5	−2561.92	− 675.77	55	− 51.94	− 587.88
6	−2477.43	− 44.55	56	− 21.98	+2052.55
7	−2403.77	+1669.71	57	− 6.71	− 358.36
8	−2406.00	− 13.45	58	+ 0.68	+ 0.08
9	−2376.91	−2405.20	59	+ 3.54	+1796.97
10	−2298.81	−1588.59	60	+ 45.52	− 376.27
11	−2215.56	+ 639.66	61	+ 67.09	− 790.09
12	−2076.15	+1551.27	62	+ 118.31	−1598.69
13	−2082.51	−2322.42	63	+ 137.10	−3128.09
14	−2006.78	+ 413.17	64	+ 163.59	+1413.46
15	−2001.93	+ 483.18	65	+ 230.18	+ 940.59
16	−1990.99	−2281.51	66	+ 270.70	+2488.35
17	−1948.40	−1185.25	67	+ 275.06	+ 985.97
18	−1916.08	+ 108.29	68	+ 283.49	+2816.98
19	−1915.45	−1381.34	69	+ 373.02	+2228.79
20	−1920.52	−2729.22	70	+ 447.02	−2090.66
21	−1787.39	+2101.63	71	+ 654.62	+1070.68
22	−1752.91	−1537.27	72	+ 754.39	− 866.19
23	−1733.18	−1681.53	73	+ 771.42	+ 879.23
24	−1665.91	−1145.63	74	+ 776.95	− 693.66
25	−1660.69	−2490.55	75	+ 890.72	−2292.94
26	−1613.90	+ 699.35	76	+ 924.81	+ 785.93
27	−1458.90	− 84.75	77	+ 940.54	− 959.03
28	−1427.55	+ 858.39	78	+ 959.61	+ 453.23
29	−1427.35	− 186.90	79	+1017.78	−1350.36
30	−1226.26	−1430.68	80	+1117.43	−1368.92
31	−1194.52	−1697.80	81	+1123.25	+1350.24
32	−1022.37	−2103.47	82	+1154.95	+ 511.38
33	− 936.14	−1389.86	83	+1263.09	+1642.15
34	− 927.37	− 383.95	84	+1263.85	+2502.30
35	− 919.82	− 560.78	85	+1326.90	+1077.05
36	− 918.70	−1303.11	86	+1354.59	−1136.15
37	− 918.06	−1394.23	87	+1356.28	+ 533.77
38	− 905.13	−1383.42	88	+1405.64	−3256.34
39	− 874.15	−2370.90	89	+1426.19	−1040.49
40	− 851.94	−1233.74	90	+1434.50	+2011.95
41	− 825.14	− 189.11	91	+1449.56	+1100.87
42	− 812.63	−2094.40	92	+1511.09	−2256.68
43	− 804.08	−1784.67	93	+1670.70	− 743.08
44	− 673.49	−1845.25	94	+1697.08	+2237.46
45	− 631.47	−2991.31	95	+1708.60	+2865.26
46	− 589.37	−1257.44	96	+1808.24	− 324.27
47	− 589.65	−2186.90	97	+1857.40	+1650.49
48	− 545.28	+ 321.71	98	+2162.13	−2127.69
49	− 399.27	+ 182.58	99	+2143.34	+ 785.03
50	− 278.14	+ 733.56	100	+2219.62	−1102.15

TABLE VIII.—34 CYGNI FINAL COÖRDINATES.—*Continued.*

Star.	*X*	*Y*	Star.	*X*	*Y*
	″	″		″	″
101	+2233.71	+ 108.88	106	+2599.51	+1067.34
102	+2266.18	+1893.08	107	+2839.14	+ 959.43
103	+2452.48	+1090.32	108	+2884.20	+2126.25
104	+2546.94	— 642.45	109	+3151.82	+ 210.38
105	+2616.40	—1002.07			

TABLE IX.—34 CYGNI DIAMETERS OF STAR IMAGES.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r		r
1	0.203	29	0.124	57	0.095	85	0.118
2	0.177	30	0.146	58	0.352	86	0.155
3	0.168	31	0.116	59	0.121	87	0.100
4	0.178	32	0.131	60	0.108	88	0.298
5	0.157	33	0.126	61	0.100	89	0.116
6	0.148	34	0.122	62	0.104	90	0.131
7	0.197	35	0.112	63	0.218	91	0.169
8	0.145	36	0.110	64	0.124	92	0.185
9	0.258	37	0.150	65	0.088	93	0.152
10	0.163	38	0.115	66	0.162	94	0.155
11	0.140	39	0.140	67	0.103	95	0 227
12	0.158	40	0.122	68	0.177	96	0.109
13	0.160	41	0.109	69	0.135	97	0.145
14	0.147	42	0.176	70	0.111	98	0.195
15	0.126	43	0.151	71	0.101	99	0.187
16	0.208	44	0.127	72	0.110	100	0 158
17	0.184	45	0.187	73	0.166	101	0.137
18	0.128	46	0.172	74	0.125	102	0.163
19	0.118	47	0.176	75	0.138	103	0.160
20	0.215	48	0.109	76	0.096	104	0.129
21	0 217	49	0.115	77	0.132	105	0.157
22	0.129	50	0.195	78	0.123	106	0.119
23	0.121	51	0.154	79	0.152	107	0.153
24	0.102	52	0.145	80	0.137	108	0.169
25	0.148	53	0.097	81	0.085	109	0.178
26	0.135	54	0.120	82	0.097		
27	0.106	55	0.109	83	0.115		
28	0.109	56	0.128	84	0.177		

TABLE X.—34 CYGNI FINAL CATALOG.

No.	Magnitude.	No. of Plates.	Right Ascension 1875.0 In Time.	Right Ascension 1875.0 In Arc.	Precession. In Time.	Precession. In Arc.	Secular Variation. In Time.	Secular Variation. In Arc.	Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	8.0	6	20 9 23.771	302 20 56.57	+2.1943	+32.9142	+0.0017	+0.0259	37 51 31.62	+10.7306	+0.2657	1875.65
2	8.2	6	9 27.081	302 21 46.22	2.2095	33.1419	0.0017	0.0262	37 22 48.50	10.7346	0.2676	75.65
3	8.3	5	9 32.082	302 23 1.23	2.1944	32.9161	0.0017	0.0259	37 51 55.91	10.7407	0.2656	75.67
4	8.2	6	9 35.676	302 23 55.14	2.2145	33.2181	0.0018	0.0264	37 13 39.59	10.7452	0.2681	75.65
5	8.4	5	9 35.691	302 23 55.36	2.2075	33.1122	0.0017	0.0262	37 27 14.89	10.7452	0.2672	75.63
6	8.5	6	9 42.294	302 25 34.41	+2.2022	+33.0337	+0.0017	+0.0262	37 37 46.83	+10.7533	+0.2665	75.65
7	8.0	6	9 47.188	302 26 47.82	2.1874	32.8109	0.0017	0.0258	38 6 21.54	10.7594	0.2646	75.65
8	8.5	5	9 48.282	302 27 4.23	2.2022	33.0331	0.0017	0.0262	37 38 18.58	10.7607	0.2664	75.63
9	7.6	6	9 52.504	302 28 7.56	2.2231	33.3458	0.0018	0.0266	36 58 27.45	10.7660	0.2689	75.65
10	8.3	6	9 58.438	302 29 36.57	2.2163	33.2440	0.0018	0.0266	37 12 4.57	10.7732	0.2680	75.65
11	8.6	6	10 3.855	302 30 57.83	+2.1971	+32.9568	+0.0017	+0.0262	37 49 13.27	+10.7799	+0.2656	75.65
12	8.4	5	10 15.019	302 33 45.28	2.1896	32.8433	0.0017	0.0261	38 4 25.91	10.7936	0.2645	75.63
13	8.4	6	10 17.013	302 34 15.19	2.2233	33.3493	0.0018	0.0268	36 59 52.61	10.7960	0.2686	75.65
14	8.5	6	10 21.617	302 35 24.25	2.1998	32.9972	0.0018	0.0264	37 45 28.46	10.8017	0.2656	75.65
15	8.8	3	10 21.981	302 35 29.72	2.1992	32.9883	0.0018	0.0264	37 46 38.50	10.8022	0.2656	75.62
16	7.9	6	10 24.626	302 36 9.39	+2.2232	+33.3485	+0.0018	+0.0269	37 0 34.19	+10.8054	+0.2685	75.65
17	8.1	6	10 27.517	302 36 52.75	2.2139	33.2088	0.0018	0.0267	37 18 50.60	10.8090	0.2673	75.65
18	8.7	6	10 29.448	302 37 21.72	2.2028	33.0417	0.0018	0.0265	37 40 24.27	10.8114	0.2659	75.65
19	8.9	5	10 30.396	302 37 35.94	2.2157	33.2359	0.0018	0.0268	37 15 34.77	10.8125	0.2675	75.63
20	7.9	6	10 30.773	302 37 41.60	2.2273	33.4095	0.0018	0.0270	36 53 7.08	10.8130	0.2689	75.65
21	7.8	6	10 39.156	302 39 47.34	+2.1857	+32.7851	+0.0017	+0.0262	38 13 38.31	+10.8232	+0.2637	75.65
22	8.7	6	10 44.093	302 41 1.40	2.2176	33.2640	0.0018	0.0269	37 12 59.95	10.8293	0.2675	75.65
23	8.8	5	10 45.823	302 41 27.34	2.2189	33.2837	0.0018	0.0270	37 10 35.83	10.8314	0.2677	75.63
24	9.1	4	10 51.173	302 42 47.59	2.2145	33.2177	0.0018	0.0269	37 19 32.10	10.8380	0.2671	75.60
25	8.5	3	10 52.304	302 43 4.56	2.2261	33.3915	0.0018	0.0271	36 57 7.39	10.8394	0.2685	75.55

TABLE X. — 34 CYGNI FINAL CATALOG. — *Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
26	8.6	6	20 10 54.597	302 43 38.95	+2.1986	+32.9794	+0.0018	+0.0266	37 50 17.29	+10.8422	+0.2651	1875.65
27	9.0	3	11 8.041	302 47 0.61	2.2060	33.0900	0.0018	0.0268	37 37 14.12	10.8587	0.2658	75.62
28	9.0	4	11 10.255	302 47 33.82	2.1979	32.9681	0.0018	0.0267	37 52 57.39	10.8614	0.2648	75.60
29	8.8	5	11 10.742	302 47 41.13	2.2070	33.1049	0.0018	0.0269	37 35 32.15	10.8620	0.2659	75.63
30	8.5	6	11 28.138	302 52 2.07	2.2184	33.2764	0.0018	0.0272	37 14 49.42	10.8833	0.2671	75.65
31	8.9	4	11 30.895	302 52 43.42	+2.2208	+33.3124	+0.0018	+0.0273	37 10 22.47	+10.8867	+0.2673	75.60
32	8.7	6	11 45.426	302 56 21.39	2.2249	33.3730	0.0018	0.0275	37 3 37.54	10.9044	0.2676	75.65
33	8.8	6	11 52.421	302 58 6.32	2.2190	33.2857	0.0018	0.0274	37 15 31.39	10.9130	0.2668	75.65
34	8.8	6	11 52.864	302 58 12.96	2.2104	33.1559	0.0018	0.0273	37 32 17.30	10.9136	0.2658	75.65
35	9.0	5	11 53.550	302 58 23.25	2.2119	33.1792	0.0018	0.0273	37 29 20.50	10.9144	0.2659	75.63
36	9.0	3	11 53.857	302 58 27.86	+2.2184	+33.2753	+0.0018	+0.0274	37 16 58.20	+10.9148	+0.2667	75.62
37	8.5	6	11 53.937	302 58 29.06	2.2191	33.2871	0.0018	0.0274	37 15 27.09	10.9149	0.2668	75.65
38	8.9	6	11 55.017	302 58 45.26	2.2191	33.2863	0.0018	0.0275	37 15 37.94	10.9162	0.2668	75.65
39	8.6	6	11 57.880	302 59 28.20	2.2276	33.4147	0.0018	0.0276	36 59 10.66	10.9197	0.2678	75.65
40	8.8	6	11 59.432	302 59 51.48	2.2180	33.2697	0.0018	0.0275	37 18 7.79	10.9216	0.2666	75.65
41	9.0	3	12 1.409	303 0 21.13	+2.2091	+33.1358	+0.0018	+0.0273	37 35 32.47	+10.9240	+0.2655	75.62
42	8.2	6	12 2.945	303 0 44.17	2.2255	33.3824	0.0018	0.0276	37 3 47.31	10.9259	0.2675	75.65
43	8.5	6	12 3.581	303 0 53.72	2.2229	33.3431	0.0018	0.0276	37 8 57.04	10.9267	0.2671	75.65
44	8.7	6	12 14.516	303 3 37.74	2.2238	33.3573	0.0018	0.0277	37 7 56.82	10.9401	0.2671	75.65
45	8.1	6	12 18.253	303 4 33.80	2.2337	33.5059	0.0019	0.0278	36 48 51.03	10.9446	0.2683	75.65
46	8.2	6	12 21.442	303 5 21.63	+2.2191	+33.2860	+0.0018	+0.0277	37 17 44.78	+10.9486	+0.2664	75.65
47	8.2	6	12 21.589	303 5 23.84	2.2270	33.4054	0.0019	0.0278	37 2 15.40	10.9487	0.2674	75.65
48	9.0	4	12 24.867	303 6 13.00	2.2056	33.0836	0.0018	0.0274	37 44 4.00	10.9527	0.2647	75.60
49	8.9	3	12 37.192	303 9 17.88	2.2073	33.1093	0.0018	0.0275	37 41 45.13	10.9678	0.2648	75.62
50	8.0	6	12 47.349	303 11 50.24	2.2029	33.0438	0.0018	0.0275	37 50 56.26	10.9802	0.2641	75.65

TABLE X.—34 CYGNI FINAL CATALOG.—*Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
51	8.4	6	20 12 50.669	303 12 40.04	+2.2317	+33.4760	+0.0019	+0.0281	36 55 18.19	+10.9842	+0.2676	1875.65
52	8.5	6	12 52.249	303 13 3.74	2.2224	33.3357	0.0019	0.0279	37 13 42.65	10.9862	0.2664	75.65
53	9.2	3	12 57.080	303 14 16.20	2.1990	32.9847	0.0018	0.0275	37 59 14.59	10.9920	0.2635	75.55
54	8.8	6	13 0.765	303 15 11.47	2.1933	32.8993	0.0018	0.0274	38 10 23.06	10.9965	0.2628	75.65
55	9.0	4	13 6.469	303 16 37.03	2.2151	33.2271	0.0019	0.0279	37 28 54.97	11.0035	0.2653	75.60
56	8.7	6	13 8.967	303 17 14.51	+2.1923	+32.8845	+0.0018	+0.0274	38 12 55.33	+11.0066	+0.2625	75.65
57	9.2	6	13 10.268	303 17 34.02	2.2133	33.1998	0.0019	0.0279	37 32 44.49	11.0081	0.2651	75.65
58	7.0	6	13 10.889	303 17 43.34	2.2102	33.1537	0.0019	0.0278	37 38 42.93	11.0088	0.2647	75.65
59	8.8	6	13 11.132	303 17 46.98	2.1946	32.9194	0.0018	0.0275	38 8 39.77	11.0092	0.2628	75.65
60	9.0	4	13 14.659	303 18 39.89	2.2136	33.2047	0.0019	0.0279	37 32 26.58	11.0135	0.2650	75.60
61	9.1	4	13 16.464	303 19 6.96	+2.2173	+33.2593	+0.0019	+0.0280	37 25 32.76	+11.0157	+0.2655	75.60
62	9.1	4	13 20.734	303 20 11.01	2.2244	33.3657	0.0019	0.0282	37 12 4.17	11.0209	0.2663	75.60
63	7.8	5	13 22.242	303 20 33.63	2.2374	33.5613	0.0019	0.0284	36 46 34.97	11.0228	0.2678	75.67
64	8.8	6	13 24.679	303 21 10.18	2.1985	32.9782	0.0018	0.0277	38 2 16.24	11.0257	0.2631	75.65
65	9.4	5	13 30.281	303 22 34.21	2.2029	33.0436	0.0019	0.0278	37 54 23.33	11.0325	0.2635	75.63
66	8.3	6	13 33.838	303 23 27.57	+2.1895	+32.8428	+0.0018	+0.0275	38 20 10.94	+11.0369	+0.2619	75.65
67	9.1	4	13 34.077	303 23 31.15	2.2027	33.0399	0.0019	0.0279	37 55 8.67	11.0371	0.2635	75.60
68	8.2	4	13 34.955	303 23 44.32	2.1867	32.8000	0.0018	0.0275	38 25 39.50	11.0382	0.2615	75.60
69	8.6	6	13 42.503	303 25 37.54	2.1922	32.8825	0.0018	0.0277	38 15 51.29	11.0474	0.2621	75.65
70	9.0	6	13 48.177	303 27 2.66	2.2297	33.4453	0.0019	0.0285	37 3 51.90	11.0543	0.2666	75.65
71	9.1	6	14 6.169	303 31 32.54	+2.2033	+33.0491	+0.0019	+0.0281	37 56 32.71	+11.0762	+0.2631	75.65
72	9.0	6	14 14.143	303 33 32.14	2.2203	33.3046	0.0019	0.0285	37 24 15.61	11.0858	0.2651	75.65
73	8.3	6	14 15.996	303 33 59.94	2.2054	33.0803	0.0019	0.0282	37 53 20.95	11.0881	0.2632	75.65
74	8.8	6	14 16.078	303 34 1.17	2.2189	33.2837	0.0019	0.0285	37 27 8.07	11.0882	0.2649	75.65
75	8.6	3	14 25.189	303 36 17.83	2.2329	33.4936	0.0019	0.0288	37 0 28.55	11.0993	0.2664	75.55

TABLE X.—34 CYGNI FINAL CATALOG.—*Continued.*

No.	Magnitude.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
76	9.2	3	20 14 28.925	303 37 13.88	+2.2067	+33.1006	+0.0019	+0.0284	37 51 47.16	+11.1038	+0.2632	1875.62
77	8.7	6	14 29.737	303 37 26.06	2.2218	33.3263	0.0019	0.0287	37 22 42.19	11.1048	0.2650	75.65
78	8.8	5	14 31.763	303 37 56.45	2.2097	33.1455	0.0019	0.0285	37 46 14.35	11.1072	0.2635	75.63
79	8.4	6	14 36.093	303 39 1.40	2.2253	33.3802	0.0019	0.0288	37 16 10.60	11.1125	0.2654	75.65
80	8.6	3	14 44.435	303 41 6.52	2.2259	33.3878	0.0019	0.0289	37 15 51.65	11.1227	0.2653	75.62
81	9.4	4	14 45.883	303 41 28.25	+2.2025	+33.0379	+0.0019	+0.0284	38 1 10.68	+11.1244	+0.2625	75.60
82	9.2	5	14 48.259	303 42 3.88	2.2099	33.1484	0.0019	0.0286	37 47 11.72	11.1273	0.2633	75.63
83	8.9	4	14 57.834	303 44 27.51	2.2005	33.0075	0.0019	0.0285	38 6 1.93	11.1389	0.2621	75.60
84	8.2	6	14 58.246	303 44 33.69	2.1930	32.8951	0.0019	0.0283	38 20 21.97	11.1394	0.2612	75.65
85	8.9	6	15 3.001	303 45 45.01	2.2056	33.0844	0.0019	0.0286	37 56 36.56	11.1452	0.2626	75.65
86	8.4	6	15 4.397	303 46 5.96	+2.2247	+33.3706	+0.0019	+0.0290	37 19 43.32	+11.1469	+0.2649	75.65
87	9.1	6	15 5.251	303 46 18.76	2.2104	33.1564	0.0019	0.0287	37 47 33.16	11.1479	0.2632	75.65
88	7.3	4	15 7.754	303 46 56.31	2.2428	33.6415	0.0020	0.0293	36 44 23.21	11.1509	0.2671	75.70
89	8.9	5	15 10.443	303 47 36.64	2.2241	33.3621	0.0019	0.0290	37 21 18.61	11.1542	0.2648	75.63
90	8.7	3	15 12.523	303 48 7.85	2.1979	32.9686	0.0019	0.0285	38 12 10.81	11.1567	0.2616	75.62
91	8.3	6	15 13.380	303 48 20.70	+2.2059	+33.0880	+0.0019	+0.0287	37 56 59.74	+11.1578	+0.2625	75.65
92	8.1	6	15 16.991	303 49 14.87	2.2347	33.5210	0.0019	0.0292	37 1 2.09	11.1622	0.2660	75.65
93	8.4	6	15 31.103	303 52 46.54	2.2225	33.3370	0.0019	0.0292	37 26 14.59	11.1793	0.2643	75.65
94	8.4	3	15 34.919	303 53 43.79	2.1969	32.9537	0.0019	0.0287	38 15 54.72	11.1838	0.2611	75.62
95	7.8	6	15 36.241	303 54 3.62	2.1915	32.8722	0.0019	0.0285	38 26 22.31	11.1855	0.2605	75.65
96	9.0	4	15 42.887	303 55 43.31	+2.2194	+33.2909	+0.0019	+0.0292	37 33 12.49	+11.1934	+0.2637	75.60
97	8.5	4	15 48.181	303 57 2.72	2.2026	33.0389	0.0019	0.0289	38 6 6.75	11.1999	0.2616	75.60
98	8.0	5	16 11.427	304 2 51.40	2.2359	33.5386	0.0020	0.0297	37 3 6.68	11.2280	0.2654	75.63
99	8.1	6	16 11.813	304 2 57.19	2.2111	33.1666	0.0020	0.0293	37 51 39.22	11.2285	0.2624	75.65
100	8.4	6	16 16.936	304 4 14.04	2.2275	33.4119	0.0020	0.0296	37 20 11.60	11.2346	0.2643	75.65

TABLE X. — 34 CYGNI FINAL CATALOG. — *Concluded.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
101	8.6	3	20 16 18.965	304 4 44.48	+2.2172	+33.2583	+0.0020	+0.0295	37 40 22.39	+11.2371	+0.2630	1875.62
102	8.3	6	16 22.983	304 5 44.74	2.2020	33.0301	0.0019	0.0292	38 10 6.09	11.2419	0.2611	75.65
103	8.4	6	16 38.150	304 9 32.25	2.2096	33.1441	0.0020	0.0295	37 56 41.79	11.2603	0.2618	75.65
104	8.7	4	16 44.742	304 11 11.13	2.2247	33.3712	0.0020	0.0298	37 27 48.35	11.2682	0.2635	75.60
105	8.4	3	16 50.281	304 12 34.21	2.2280	33.4205	0.0020	0.0299	37 21 48.12	11.2749	0.2639	75.62
106	8.8	3	16 50.558	304 12 38.37	+2.2104	+33.1553	+0.0020	+0.0296	37 56 17.41	+11.2752	+0.2617	75.62
107	8.4	6	17 10.712	304 17 40.68	2.2122	33.1824	0.0020	0.0298	37 54 27.06	11.2996	0.2617	75.65
108	8.3	4	17 15.589	304 18 53.84	2.2023	33.0345	0.0020	0.0296	38 13 53.14	11.3054	0.2604	75.60
109	8.2	5	17 36.377	304 24 5.66	2.2197	33.2955	0.0020	0.0302	37 41 54.62	11.3305	0.2622	75.63

TABLE I.—PHOTOGRAPHS OF γ CYGNI.

OBSERVATORY OF L. M. RUTHERFURD, NEW YORK.

Lat. 40° 43′ 48″.5. Long. $4^h\ 55^m\ 56^s.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Zen. Dist.
				Att.	Ext.	Tel.		
		h m s	in.					°
1	1875 July 19	18 33 8	30.218	68°	65°	69°	7.64	19.9
2	1875 July 19	19 7 43	30.218	68	65	69	7.64	13.4
3	1875 July 19	19 34 18	30.218	68	65	69	7.64	8.3
5	1875 Oct. 20	22 7 38	30.032	54	53	55	7.75	20.9
6	1875 Oct. 20	22 40 32	30.032	54	53	55	7.75	27.0
7	1876 Nov. 29	0 29 18	29.964	38	37	38	7.9	46.9
11	1876 Dec. 5	0 50 38	30.120	33	32	35	7.95	50.6

TABLE II.—γ CYGNI CORRECTED COÖRDINATES.

PLATE 1.

Star.	*X*	*Y*
1	−54.4084	−20.3832
4	−52.2895	−8.1851
5	−52.1043	−24.3270
6	−50.7134	−27.8970
8	−46.3295	−1.1922
9	−44.1317	−33.5243
10	−35.5809	+14.5480
11	−34.4703	−22.9060
13	−29.9929	−42.1514
14	−26.6988	−57.6072
15	−24.4178	−42.3556
16	−23.3996	+6.7936
17	−22.6239	−15.2689
18	−22.5492	−26.5262
19	−22.2528	−27.2282
20	−22.0436	−8.3798
21	−21.9054	−46.4481
22	−20.4694	−29.0912
23	−19.5176	+17.7036
25	−17.7860	−53.0198
26	−17.2002	−2.9288
27	−15.4273	−31.4445
28	−14.8663	−24.4879
29	−13.2086	−43.8112
30	−11.5792	+37.1779
31	−10.8725	−30.2604
32	−9.2955	−28.9422
33	−7.9274	+13.0578
34	−8.0037	−55.1966
35	−6.9435	+9.0130
36	−6.7292	+40.6400
37	−6.5432	−4.7996
38	−5.1018	+19.4750
39	−4.5509	−54.2141
40	−2.8976	−28.8094
41	−1.9245	+32.9857
42	−1.3374	+13.3326
43	−1.1350	+49.6270
44	−0.6496	−35.9745
45	0.0000	0.0000
46	+0.5408	−31.3121
47	+2.0679	−9.1957
48	+4.7992	−19.6678
49	+6.8072	+22.4620
50	+7.0743	+31.0886
51	+7.1307	+38.0184
52	+7.4182	+52.3724
53	+8.8479	+13.6224
54	+9.2960	+17.6909
55	+10.6749	+43.1610
56	+10.8866	+23.3990
57	+11.3268	+23.9090
58	+11.7742	+36.8423
59	+12.0893	+4.2421
60	+12.1161	+40.4750
61	+12.6305	+34.4171
62	+12.7774	+41.9334
63	+14.2354	+33.3314
64	+14.2806	+34.0320
65	+14.8931	−6.9967
66	+14.9599	+32.4378
67	+18.0127	−41.3548
68	+18.5139	+28.8874
69	+19.3965	+32.5024
70	+22.8350	−8.8329
71	+23.2196	−48.9094
72	+23.8358	+5.3940
73	+26.6322	+15.7566
74	+27.1332	+26.3350
75	+28.3189	−29.6768
76	+29.2175	+39.0012
77	+32.3966	−11.4820
78	+33.4957	−7.3403
79	+33.4166	+10.4304
80	+35.5569	−28.7137
81	+39.1646	−16.4870
82	+40.7536	−3.0412
83	+41.2089	+28.4306
84	+42.0230	−31.8728
86	+44.0234	−4.9188
87	+45.5744	−13.2842
88	+47.2756	−7.9852
89	+47.0930	+22.8894
90	+47.7283	−16.6781
91	+47.6233	+21.7097
92	+49.7962	+9.4915
93	+50.8413	−5.0008
94	+56.7731	+14.4195
95	+58.4168	+5.7757

PLATE 2.

Star.	*X*	*Y*
1	−54.4016	−20.3706
3	−53.3438	−45.7718
4	−52.2834	−8.1725
5	−52.1000	−24.3154
6	−50.7084	−27.8863
8	−46.3202	−1.1832
9	−44.1292	−33.5128
10	−35.5677	+14.5554
11	−34.4675	−22.8998
12	−30.8588	−47.1284
13	−29.9957	−42.1437
14	−26.7038	−57.6013
15	−24.4175	−42.3498
16	−23.3948	+6.7999
17	−22.6200	−15.2668
18	−22.5472	−26.5196
19	−22.2492	−27.2200
20	−22.0367	−8.3760
21	−21.9062	−46.4427
22	−20.4683	−29.0879
23	−19.5096	+17.7064
24	−19.0118	−43.4334
25	−17.7939	−53.0175
26	−17.1915	−2.9204
27	−15.4236	−31.4356
28	−14.8634	−24.4834
29	−13.2064	−43.8084
30	−11.5619	+37.1836
31	−10.8667	−30.2570
32	−9.2927	−28.9428
33	−7.9203	+13.0606
34	−8.0069	−55.1944
35	−6.9354	+9.0128
36	−6.7143	+40.6397
37	−6.5348	−4.7990
38	−5.0906	+19.4758
39	−4.5502	−54.2056
40	−2.8960	−28.8084
41	−1.9048	+32.9876
42	−1.3261	+13.3340
43	−1.1208	+49.6288
44	−0.6539	−35.9737
45	0.0000	0.0000
46	+0.5436	−31.3076
47	+2.0722	−9.1933
48	+4.8018	−19.6657
49	+6.8200	+22.4617
50	+7.0812	+31.0917
51	+7.1542	+38.0129
52	+7.4394	+52.3726
53	+8.8580	+13.6247
54	+9.3045	+17.6909
55	+10.6931	+43.1602
56	+10.9021	+23.3916
57	+11.3375	+23.9073

TABLE II.—γ CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 2.

Star.	*X*	*Y*
58	+11.7848	+36.8412
59	+12.0934	+ 4.2398
60	+12.1297	+40.4746
61	+12.6430	+34.4178
62	+12.7930	+41.9292
63	+14.2464	+33.3284
64	+14.2933	+34.0281
65	+14.8983	− 6.9976
66	+14.9762	+32.4380
67	+18.0159	−41.3587
68	+18.5266	+28.8861
69	+19.4121	+32.4996
70	+22.8376	− 8.8382
72	+23.8413	+ 5.3888
73	+26.6432	+15.7535
74	+27.1468	+26.3305
75	+28.3192	−29.6807
76	+29.2334	+38.9938
77	+32.4000	−11.4847
78	+33.4993	− 7.3462
79	+33.4259	+10.4265
80	+35.5600	−28.7202
81	+39.1655	−16.4934
82	+40.7620	− 3.0439
83	+41.2156	+28.4215
84	+42.0254	−31.8800
85	+42.4570	−11.1852
86	+44.0237	− 4.9231
87	+45.5772	−13.2889
88	+47.2805	− 7.9898
90	+47.7318	−16.6856
91	+47.6330	+21.7049
92	+49.8066	+ 9.4797
93	+50.8488	− 5.0092
94	+56.7794	+14.4154
95	+58.4203	+ 5.7662

PLATE 3.

Star.	*X*	*Y*
4	−52.2908	− 8.1919
5	−52.1080	−24.3335
6	−50.7150	−27.8998
7	−49.6844	+ 9.8600
8	−46.3285	− 1.1958
9	−44.1352	−33.5282
10	−35.5758	+14.5441
11	−34.4734	−22.9109
12	−30.8590	−47.1405
13	−29.9966	−42.1580

PLATE 3.

Star.	*X*	*Y*
14	−26.7054	−57.6129
15	−24.4186	−42.3615
16	−23.3967	+ 6.7901
17	−22.6216	−15.2757
18	−22.5441	−26.5293
19	−22.2539	−27.2312
20	−22.0351	− 8.3842
21	−21.9078	−46.4545
22	−20.4703	−29.0957
23	−19.5128	+17.6988
24	−19.0088	−43.4447
25	−17.7926	−53.0290
26	−17.1937	− 2.9304
27	−15.4260	−31.4505
28	−14.8593	−24.4917
29	−13.2087	−43.8161
30	−11.5655	+37.1731
31	−10.8689	−30.2627
32	− 9.2908	−28.9495
33	− 7.9206	+13.0536
34	− 8.0030	−55.2020
35	− 6.9386	+ 9.0043
36	− 6.7201	+40.6366
37	− 6.5357	− 4.8058
38	− 5.0948	+19.4702
39	− 4.5503	−54.2192
40	− 2.8961	−28.8169
41	− 1.9106	+32.9776
42	− 1.3322	+13.3275
43	− 1.1222	+49.6231
44	− 0.6520	−35.9821
45	0.0000	0.0000
46	+ 0.5390	−31.3206
47	+ 2.0717	− 9.2005
48	+ 4.8022	−19.6712
49	+ 6.8202	+22.4604
50	+ 7.0766	+31.0842
51	+ 7.1452	+38.0072
52	+ 7.4317	+52.3693
53	+ 8.8528	+13.6195
54	+ 9.3033	+17.6802
55	+10.6921	+43.1534
56	+10.9004	+23.3894
57	+11.3364	+23.9018
58	+11.7872	+36.8372
59	+12.0980	+ 4.2327
60	+12.1270	+40.4712
61	+12.6459	+34.4145
62	+12.7912	+41.9246

PLATE 3.

Star.	*X*	*Y*
63	+14.2467	+33.3214
64	+14.2925	+34.0264
65	+14.8986	− 7.0048
66	+14.9708	+32.4281
67	+18.0136	−41.3648
68	+18.5254	+28.8828
69	+19.4052	+32.4982
70	+22.8376	− 8.8426
71	+23.2185	−49.9131
72	+23.8418	+ 5.3877
73	+26.6443	+15.7480
74	+27.1453	+ 26.3275
75	+28.3205	−29.6874
76	+29.2355	+38.9914
77	+32.3975	−11.4895
78	+33.5003	− 7.3474
79	+33.4323	+10.4235
80	+35.5607	−28.7217
81	+39.1666	−16.4919
82	+40.7597	− 3.0481
83	+41.2171	+28.4246
84	+42.0264	−31.8834
86	+44.0275	− 4.9278
87	+45.5819	−13.2930
88	+47.2836	− 7.9956
89	+47.1065	+22.8820
90	+47.7330	−16.6869
91	+47.6303	+21.7026
92	+49.8041	+ 9.4825
93	+50.8470	− 5.0082
94	+56.7803	+14.4113
95	+58.4212	+ 5.7655

PLATE 5.

Star.	*X*	*Y*
1	−54.3787	−20.3736
4	−52.2690	− 8.1823
5	−52.0794	−24.3202
6	−50.6862	−27.8878
7	−49.6601	+ 9.8722
8	−46.3036	− 1.1842
9	−44.1028	−33.5149
10	−35.5562	+14.5534
12	−30.8289	−47.1264
13	−29.9680	−42.1419
14	−26.6724	−57.6086
15	−24.3917	−42.3495
17	−22.6008	−15.2630
18	−22.5192	−26.5186

TABLE II.—γ CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 5.

Star.	X	Y
19	−22.2249	−27.2204
20	−22.0104	− 8.3690
23	−19.4862	+17.7124
24	−18.9851	−43.4282
25	−17.7608	−53.0110
26	−17.1694	− 2.9156
29	−13.1820	−43.8028
30	−11.5514	+37.1882
31	−10.8444	−30.2481
32	− 9.2631	−28.9359
33	− 7.9010	+13.0671
34	− 7.9746	−55.1896
35	− 6.9153	+ 9.0196
37	− 6.5154	− 4.7940
38	− 5.0766	+19.4845
40	− 2.8672	−28.8004
42	− 1.3088	+13.3401
43	− 1.1103	+49.6335
44	− 0.6241	−35.9687
45	0.0000	0.0000
48	+ 4.8308	−19.6611
49	+ 6.8344	+22.4718
50	+ 7.0918	+31.0960
52	+ 7.4381	+52.3786
54	+ 9.3222	+17.6967
56	+10.9158	+23.4030
57	+11.3541	+23.9182
58	+11.7938	+36.8500
60	+12.1404	+40.4785
61	+12.6533	+34.4288
62	+12.7996	+41.9402
63	+14.2605	+33.3390
64	+14.3062	+34.0370
65	+14.9207	− 6.9884
67	+18.0429	−41.3507
68	+18.5412	+28.8987
70	+22.8609	− 8.8268
71	+23.2446	−48.8972
72	+23.8646	+ 5.4027
73	+26.6625	+15.7665
74	+27.1590	+26.3414
75	+28.3441	−29.6682
76	+29.2445	+39.0060
77	+32.4188	−11.4710
78	+33.5200	− 7.3311
80	+35.5856	−28.7065
81	+39.1900	−16.4766
82	+40.7774	− 3.0306
83	+41.2351	+28.4386
84	+42.0495	−31.8631
85	+42.4734	−11.1716
87	+45.6013	−13.2743
89	+47.1199	+22.8950
92	+49.8132	+ 9.4956
93	+50.8671	− 4.9923
95	+58.4326	+ 5.7807

PLATE 6.

Star.	X	Y
1	−54.3801	−20.3704
2	−52.5642	+33.3496
3	−53.3186	−45.7708
4	−52.2644	− 8.1752
5	−52.0818	−24.3165
6	−50.6858	−27.8836
7	−49.6576	+ 9.8756
8	−46.3000	− 1.1816
9	−44.1032	−33.5110
13	−29.9675	−42.1402
14	−26.6753	−57.6036
15	−24.3896	−42.3478
18	−22.5182	−26.5168
24	−18.9850	−43.4246
25	−17.7631	−53.0132
26	−17.1671	− 2.9132
29	−13.1821	−43.8008
30	−11.5482	+37.1852
31	−10.8420	−30.2543
32	− 9.2680	−28.9342
33	− 7.8987	+13.0686
34	− 7.9778	−55.1866
37	− 6.5092	− 4.7918
40	− 2.8675	−28.7994
42	− 1.3069	+13.3422
43	− 1.1054	+49.6366
44	− 0.6249	−35.9669
45	0.0000	0.0000
48	+ 4.8287	−19.6542
49	+ 6.8394	+22.4721
50	+ 7.0980	+31.0970
52	+ 7.4470	+52.3812
56	+10.9196	+23.4062
57	+11.3604	+23.9197
58	+11.8028	+36.8529
60	+12.1465	+40.4842
62	+12.8057	+41.9402
64	+14.3100	+34.0385
67	+18.0421	−41.3488
69	+19.4214	+32.5189
70	+22.8658	− 8.8272
71	+23.2452	−48.8954
74	+27.1628	+26.3356
76	+29.2501	+39.0070
78	+33.5237	− 7.3340
80	+35.5856	−28.7071
81	+39.1895	−16.4792
82	+40.7838	− 3.0350
83	+41.2363	+28.4382
84	+42.0484	−31.8659
85	+42.4749	−11.1702
87	+45.5992	−13.2785
89	+47.1200	+22.8943
92	+49.8137	+ 9.4946
93	+50.8685	− 4.9955
95	+58.4322	+ 5.7809

PLATE 7

Star.	X	Y
1	−54.3296	−20.4618
2	−52.6262	+33.2604
4	−52.2391	− 8.2630
5	−52.0266	−24.4026
6	−50.6238	−27.9662
8	−46.2938	− 1.2589
9	−44.0348	−33.5761
13	−29.8839	−42.1878
15	−24.3057	−42.3865
23	−19.5252	+17.6806
24	−18.9017	−43.4570
25	−17.6603	−53.0356
29	−13.0962	−43.8222
30	−11.6234	+37.1696
31	−10.7904	−30.2646
32	− 9.2080	−28.9501
33	− 7.9300	+13.0569
34	− 7.8697	−55.1978
37	− 6.5051	− 4.7994
38	− 5.1185	+19.4823
40	− 2.8179	−28.8018
42	− 1.3374	+13.3420
43	− 1.2122	+49.6363
44	− 0.5603	−35.9604
45	0.0000	0.0000
48	+ 4.8585	−19.6472
49	+ 6.7866	+22.4880
50	+ 7.0320	+31.1114
52	+ 7.3338	+52.3953

TABLE II.—γ CYGNI CORRECTED COÖRDINATES.—*Concluded.*

PLATE 7.			PLATE XI.			PLATE XI.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
56	+10.8624	+23.4240	1	−54.3584	−20.3513	43	− 1.1191	+49.6356
57	+11.3013	+23.9373	2	−52.5516	+33.3578	44	− 0.6283	−35.9622
58	+11.7198	+36.8718	3	−53.2992	−45.7605	45	0.0000	0.0000
60	+12.0503	+40.5051	4	−52.2492	− 8.1598	48	+ 4.8135	−19.6563
62	+12.7165	+41.9604	5	−52.0583	−24.3023	49	+ 6.8252	+22.4724
64	+14.2332	+34.0618	6	−50.6703	−27.8708	50	+ 7.0780	+31.0996
65	+14.9340	− 6.9612	7	−49.6548	+ 9.8856	57	+11.3482	+23.9122
67	+18.1130	−41.3129	8	−46.2925	− 1.1700	58	+11.7893	+36.8470
70	+22.8730	− 8.7825	9	−44.0863	−33.4958	62	+12.7854	+41.9370
71	+23.3300	−48.8531	13	−29.9569	−42.1268	67	+18.0298	−41.3484
72	+23.8440	+ 5.4442	14	−26.6603	−57.5926	70	+22.8428	− 8.8226
73	+26.6236	+15.8062	15	−24.3850	−42.3356	71	+23.2352	−48.8942
74	+27.1003	+26.3907	18	−22.5166	−26.5069	72	+23.8496	+ 5.3986
76	+29.1656	+39.0571	23	−19.5036	+17.7222	74	+27.1398	+26.3385
77	+32.4352	−11.4140	24	−18.9737	−43.4162	76	+29.2363	+39.0002
78	+33.5232	− 7.2721	25	−17.7552	−52.9956	78	+33.5048	− 7.3360
80	+35.6272	−28.6430	26	−17.1712	− 2.9108	80	+35.5644	−28.7105
81	+39.2110	−16.4098	29	−13.1848	−43.7918	81	+39.1742	−16.4819
83	+41.1708	+28.5119	30	−11.5539	+37.1900	82	+40.7589	− 3.0338
84	+42.0976	−31.7919	31	−10.8556	−30.2430	83	+41.2168	+28.4358
85	+42.4862	−11.0968	32	− 9.2607	−28.9259	84	+42.0349	−31.8696
87	+45.6101	−13.1967	33	− 7.9012	+13.0728	85	+42.4610	−11.1760
89	+47.0660	+22.9770	34	− 7.9714	−55.1781	87	+45.5763	−13.2783
92	+49.7827	+ 9.5821	37	− 6.5142	− 4.7841	89	+47.1003	+22.8906
93	+50.8629	− 4.9043	38	− 5.0916	+19.4920	92	+49.7925	+ 9.4878
95	+58.4025	+ 5.8810	40	− 2.8718	−28.7963	93	+50.8421	− 4.9991
			42	− 1.3142	+13.3448	95	+58.4176	+ 5.7738

Table III.—γ Cygni Refraction Coefficients.

Plate.	M_x	N_x	M_y	N_y
1	+0.000316	+0.000076	—0.000090	+0.000282
2	+ .000296	+ .000052	— .000057	+ .000281
3	+ .000286	+ .000033	— .000035	+ .000281
5	+ .000325	— .000081	+ .000097	+ .000287
6	+ .000356	— .000101	+ .000135	+ .000289
7	+ .000581	— .000124	+ .000361	+ .000343
11	+ .000666	— .000109	+ .000444	+ .000375

TABLE IV.—PLATE CONSTANTS.

Plate.	*p*	*r*	Probable Error of *p* or *r*.	*k*	*c*	Probable Error of *k* or *c*.	Probable Error of One Equation.
1	+0.000005	—0.000365	±0.000007	+0.″801	+0.″252	±0.″015	±0.″0933
2	+ .000029	— .000519	.000006	+ .445	+ .221	.013	.0806
3	— .000033	— .000410	.000007	+ .555	+ .548	.016	.0967
5	+ .000010	— .000167	.000005	— .518	— .135	.012	.0749
6	— .000007	— .000210	.000006	— .632	— .190	.014	.0876
7	— .000014	+ .001755	.000006	— .374	— .326	.013	.0821
11	+ .000010	— .000082	.000008	— .276	— .369	.019	.1168

TABLE V.—γ CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.

Star.	X_m	1	2	3	5	6	7	11
1	—2876″.21	—.17	+.02		.00	—.17	+.04	+.27
2	—2781.18					—.04	—.25	+.28
3	—2819.70		+.07			—.11		+.05
4	—2764.58	+.07	+.11	—.01	—.21	—.10	+.06	+.10
5	—2754.53	+.07	+.14	—.10	—.03	—.22	—.16	+.32
6	—2680.80	—.05	+.12	—.07	—.03	—.06	+.01	+.06
7	—2627.17			+.05	+.11	+.06		—.23
8	—2449.38	—.02	+.12	—.05	—.01	+.04	—.02	—.02
9	—2332.62	—.06	+.03	—.18	+.04	—.02	—.08	+.27
10	—1881.12	—.06	+.14	+.01	—.08			
11	—1821.94	+.06	+.07	—.12				
12	—1630.41		—.01	—.03	+.04			
13	—1584.85	+.07	—.05	—.07	—.05	—.01	—.01	+.11
14	—1410.40	+.06	—.02	—.17	.00	—.09		+.22
15	—1289.91	—.03	+.03	—.02	—.08	+.05	+.11	—.04
16	—1236.91	+.07	—.09	+.03				
17	—1195.51	+.03	+.03	+.06	—.11			
18	—1191.24	—.12	—.12	+.10	+.08	+.08		—.02
19	—1175.65	—.02	+.07	—.12	+.07			
20	—1164.69	—.20	—.11	+.12	+.20			
21	—1157.01	+.01	+.05	—.07				
22	—1081.36	+.03	+.02	—.04				
23	—1031.77	+.07	—.03	+.07	+.43		+.03	—.55
24	—1003.92		—.04	+.09	—.11	—.09	—.10	+.26
25	— 939.19	+.15	—.13	—.12	+.04	—.04	+.03	+.10
26	— 908.65	—.17	—.04	.00	+.12	+.13		—.05
27	— 814.57	—.05	+.08	—.03				
28	— 784.96	—.10	—.08	+.19				
29	— 697.09	—.01	+.17	.00	—.02	—.01	+.14	—.29
30	— 611.97	—.18	+.02	+.16	+.04	—.04	—.07	+.06
31	— 573.74	—.01	+.23	+.12	+.08	+.19	—.05	—.56
32	— 490.16	—.21	—.16	—.03	+.11	—.17	+.19	+.24
33	— 418.62	—.03	—.14	+.05	+.05	+.03	—.13	+.18
34	— 421.57	—.08	—.08	.00	+.02	—.10	+.13	+.12
35	— 366.51	—.05	—.05	—.05	+.14			
36	— 355.67	—.03	+.01	+.03				
37	— 344.97	—.21	—.06	—.01	—.07	+.16	+.07	+.10
38	— 269.40	+.08	+.14	+.14	+.14		—.06	—.44
39	— 238.97	—.09	+.11	—.03				
40	— 151.93	—.09	—.08	—.10	+.14	+.12	+.01	+.02
41	— 101.24	—.24	+.14	+.09				
42	— 70.02	—.12	.00	—.14	+.10	+.05	+.05	+.07
43	— 59.98	.00	—.08	+.20	+.09	+.07	—.26	—.01
44	— 33.12	+.12	—.13	—.08	+.06	+.03	+.01	—.03
45	0.00	+.80	+.44	+.56	—.52	—.63	—.37	—.28
46	+ 29.84	+.04	+.13	—.16				
47	+ 110.29	+.02	—.01	.00				
48	+ 254.93	—.02	—.04	—.03	+.29	+.13	+.02	—.35
49	+ 360.62	—.15	—.04	+.16	+.02	+.10	—.04	—.03
50	+ 374.20	+.26	—.02	—.03	—.06	+.05	+.10	—.33
51	+ 377.62	—.28	+.25	+.04				

TABLE V.—γ CYGNI MEAN *Y* AND RESIDUALS FOR EACH PLATE.

Star.	Y_m	1	2	3	5	6	7	11
1	−1078″.42	−.09	−.01		+.06	−.04	−.09	+.16
2	+1762.54					.00	+.07	−.06
3	−2421.89		+.10			+.15		−.25
4	− 433.47	+.09	+.21	−.23	−.12	−.01	−.02	+.07
5	−1287.11	+.07	+.11	−.20	+.05	.00	+.03	−.06
6	−1475.79	−.03	−.03	−.09	+.08	+.05	+.14	−.08
7	+ 521.14			−.14	+.14	+.04		−.04
8	− 63.51	+.04	+.02	−.10	+.09	−.01	+.02	−.03
9	−1773.20	−.13	−.03	−.21	−.01	−.02	+.37	+.01
10	+ 769.07	+.03	+.08	−.09	−.03			
11	−1211.69	+.05	−.02	−.04				
12	−2492.95		−.03	−.05	+.08			
13	−2229.34	−.03	+.01	−.15	+.09	+.03	+.01	+.04
14	−3046.93	+.23	+.18	+.20	−.24	−.11		−.27
15	−2240.16	+.08	+.06	+.02	.00	−.04	−.07	−.03
16	+ 359.21	−.02	+.06	−.04				
17	− 807.67	+.09	−.07	−.06	+.03			
18	−1402.90	−.02	+.05	+.05	.00	−.04		−.06
19	−1439.97	−.06	+.08	+.01	−.04			
20	− 443.21	−.03	−.09	−.06	+.17			
21	−2456.51	+.03	.00	−.03				
22	−1538.57	+.03	−.07	+.04				
23	+ 936.24	−.02	−.08	−.12	+.08		−.06	+.18
24	−2297.20		−.07	−.12	+.08	+.15	−.07	+.01
25	−2804.00	+.02	−.13	−.14	+.10	−.12	+.07	+.18
26	− 154.70	−.18	+.06	−.06	+.14	+.14		−.10
27	−1662.85	−.07	+.17	−.11				
28	−1294.98	−.04	.00	+.04				
29	−2316.90	.00	−.07	+.05	+.04	+.07	−.08	.00
30	+1966.29	−.04	+.15	−.15	+.13	−.15	+.04	+.02
31	−1600.18	−.05	−.05	+.13	+.19	−.20	+.03	−.05
32	−1530.59	+.10	−.10	+.02	+.03	+.05	−.14	+.06
33	+ 690.77	−.07	−.03	−.08	+.05	+.03	+.04	+.06
34	−2918.95	+.01	−.06	+.08	−.03	+.07	−.06	−.03
35	+ 476.72	+.09	−.01	−.13	+.06			
36	+2149.39	+.02	−.04	+.02				
37	− 253.69	+.03	−.04	−.03	−.06	−.03	+.02	+.11
38	+1030.24	−.12	−.13	−.14	+.02		+.18	+.19
39	−2866.80	−.14	+.17	−.02				
40	−1523.38	.00	−.04	−.05	+.08	+.09	+.02	−.12
41	+1744.63	+.04	+.13	−.16				
42	+ 705.36	−.03	+.02	−.04	−.02	+.02	+.03	+.04
43	+2624.81	−.04	+.07	−.06	−.07	+.01	+.08	+.02
44	−1902.31	+.03	.00	+.01	−.07	+.01	+.17	−.12
45	0.00	+.25	+.22	+.55	−.14	−.19	−.33	−.37
46	−1655.66	−.03	+.15	−.11				
47	− 485.98	−.06	+.05	+.02				
48	−1039.74	−.07	+.03	+.10	−.12	+.22	−.03	−.13
49	+1188.38	−.12	−.08	+.08	+.02	−.01	+.12	+.02
50	+1644.57	−.09	+.15	−.05	−.07	−.06	−.02	+.14
51	+2010.78	+.18	−.03	−.15				

TABLE V.—γ CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.—*Continued.*

Star.	X_m	1	2	3	5	6	7	11
52	+ 392″.35	—.02	+.26	+.17	—.18	+.02	—.24	
53	+ 468.52	+.01	+.06	—.07				
54	+ 492.18	—.02	—.08	.00	+.10			
55	+ 564.91	—.21	—.01	+.21				
56	+ 576.41	—.22	+.04	+.12	+.07	+.10	—.13	
57	+ 599.63	—.14	—.16	—.04	+.04	+.17	—.11	+.24
58	+ 622.93	+.01	—.14	+.23	—.19	+.06	—.14	+.15
59	+ 640.10	+.01	—.16	+.15				
60	+ 640.95	+.02	+.01	+.10	+.08	+.16	—.37	
61	+ 668.34	—.09	—.08	+.28	—.11			
62	+ 675.94	—.02	+.06	+.21	—.07	+.02	00	—.22
63	+ 753.20	—.04	—.12	+.10	+.04			
64	+ 755.60	—.06	—.05	+.10	+.05	+.04	—.09	
65	+ 788.68	—.12	—.13	—.10	+.01		+.36	
66	+ 791.60	—.12	+.10	+.01				
67	+ 954.16	—.10	+.12	—.16	+.12	+.11	+.07	—.14
68	+ 979.60	—.10	—.04	+.06	+.10			
69	+1026.14	—.02	+.16	—.02		—.12		
70	+1208.60	+.01	—.12	—.14	+.02	+.25	+.24	—.27
71	+1229.51	+.05		—.12	—.04	+.06	+.07	—.02
72	+1261.38	—.06	—.16	—.10	+.17		+.06	+.07
73	+1409.25	—.20	—.10	+.03	+.14		+.13	
74	+1435.48	—.09	+.03	+.09	+.04	+.06	+.01	—.17
75	+1498.90	+.05	+.01	—.08	+.02			
76	+1545.74	—.30	—.18	+.11	—.10	—.02	+.11	+.36
77	+1714.27	+.07	+.01	—.20	—.09		+.20	
78	+1772.38	+.02	—.07	—.06	.00	+.13	—.01	+.01
79	+1768.10	—.15	—.11	+.26				
80	+1881.78	—.06	+.05	—.08	+.12	+.12	+.04	—.20
81	+2072.32	+.02	—.12	—.18	+.05	.00	+.15	+.11
82	+2156.22	—.04	+.10	—.10	—.08	+.19		—.09
83	+2179.83	—.05	—.30	—.14	+.11	.00	+.17	+.21
84	+2223.80	—.04	+.03	—.11	.00	—.04	+.05	+.14
85	+2246.11		+.05		—.16	—.13	+.08	+.15
86	+2328.99	+.16	—.13	—.02				
87	+2411.27	+.03	—.05	+.08	+.13	—.01	—.01	—.16
88	+2501.19	—.01	—.01	+.03				
89	+2491.23	—.17		+.01	+.01	—.14	+.17	+.13
90	+2525.23	+.03	+.03	—.07				
91	+2519.06	+.06	+.03	—.09				
92	+2634.04	+.19	+.30	+.13	—.18	—.26	—.10	—.10
93	+2689.74	—.02	+.09	—.13	+.04	+.07	+.10	—.13
94	+3003.04	+.09	—.04	—.05				
95	+3089.93	+.27	+.05	+.02	—.16	—.27	—.31	+.37

TABLE V.—γ CYGNI MEAN *Y* AND RESIDUALS FOR EACH PLATE.—*Continued.*

Star.	Y_m	1	2	3	5	6	7	11
52	+2770.13	—.05	+.07	+.02	—.08	—.01	+.05	
53	+ 720.93	—.12	+.07	+.04				
54	+ 935.91	+.07	+.15	—.20	—.01			
55	+2282.97	+.01	+.10	—.12				
56	+1237.74	+.14	—.16	—.06	—.02	+.12	—.02	
57	+1264.85	+.01	+.03	—.07	+.11	+.16	—.03	—.18
58	+1948.87	—.04	+.03	—.02	00	+.11	—.01	—.06
59	+ 224.72	+.05	+.03	—.09				
60	+2140.97	—.02	+.10	+.06	—.19	+.06	+.01	
61	+1820.73	—.15	+.03	+.01	+.11			
62	+2218.02	+.08	00	—.12	+.07	+.03	—.12	+.03
63	+1763.14	+.06	+.04	—.18	+.08			
64	+1800.18	+.06	+.02	+.08	—.04	+.02	—.12	
65	— 369.55	—.01	+.06	—.03	+.04		—.04	
66	+1715.94	+.01	+.18	—.19				
67	—2186.64	+.09	00	+.05	—.11	+.05	+.07	—.16
68	+1528.34	—.10	+.01	—.01	+.11			
69	+1719.58	—.16	—.12	—.04		+.32		
70	— 466.55	00	—.10	—.07	—.07	—.04	+.06	+.20
71	—2585.76	—.23		+.09	—.01	+.16	00	00
72	+ 285.86	00	—.06	+.08	+.06		—.03	—.04
73	+ 833.91	+.02	+.11	—.02	+.15		—.26	
74	+1393.34	+.03	+.07	+.02	—.01	—.29	+.07	+.10
75	—1568.80	00	00	—.05	+.04			
76	+2063.18	+.08	00	—.05	—.04	+.05	—.04	00
77	— 606.40	—.10	+.02	—.01	+.07		+.02	
78	— 387.42	—.04	—.05	+.08	+.04	—.02	+.02	—.02
79	+ 552.42	—.06	+.04	+.02				
80	—1517.78	+.02	—.05	+.13	—.02	+.06	—.02	—.11
81	— 871.01	—.10	—.10	+.19	+.04	+.03	—.08	—.01
82	— 159.85	—.15	+.09	+.02	+.01	—.11		+.15
83	+1504.51	—.10	—.18	+.03	—.08	00	+.05	+.25
84	—1684.73	—.01	—.05	+.02	+.09	+.08	—.09	—.06
85	— 590.29		+.01		—.07	+.13	—.05	—.01
86	— 259.16	—.08	+.10	—.01				
87	— 701.53	—.10	+.06	+.01	+.01	—.05	—.10	+.14
88	— 421.29	—.07	+.11	—.05				
89	+1211.47	—.03		+.08	—.12	—.04	—.08	+.17
90	— 881.03	—.05	—.02	+.07				
91	+1149.18	—.12	+.10	+.01				
92	+ 502.85	+.08	—.07	+.15	—.11	00	—.07	—.02
93	— 263.42	—.05	—.03	+.14	—.03	—.03	—.03	+.06
94	+ 763.82	—.16	+.17	—.02				
95	+ 306.54	+.01	+.06	+.07	—.14	+.07	—.14	+.09

TABLE VI.—γ CYGNI CONCORDANCE WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.
2	14024	24	9285	43	14115	76	14173
3	9231	25	9287	45	9311	78	9358
4	9234	29	9293	50	14128	80	9360
5	9235	30	14094	52	14131	81	9361
6	9238	32	9297	56	9326	84	9362
7	14031	33	14104	57	14139	85	9363
8	9245	34	9299	58	14141	89	14198
9	9250	37	9302	62	14143	92	14201
12	9270	39	9306	64	14148	95	9392
13	9272	40	9307	67	9337		
14	9275	41	14112	71	9344		
15	9279	42	14114	72	14163		

TABLE VII.—γ CYGNI COMPARISON WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

$p = +0.000324 \quad \pm 0.000026$
$r = +0.000524 \quad \pm 0.000026$
$k = +0''.540 \quad \pm 0''.062$
$c = +0''.227 \quad \pm 0''.062$
Probable error of a single equation = ± 0.4117

RESIDUALS.

Star.	v_x	v_y	Star.	v_x	v_y
	″	″		″	″
2	−0.66	+0.54	42	−0.70	+0.64
3	+1.04	−0.30	43	+0.01	+0.57
4	+0.23	−0.14	45	+0.54	+0.23
5	+0.15	−0.62	50	−1.05	−0.49
6	+0.46	−0.16	52	−0.83	+0.26
7	−1.09	+1.68	56	−1.14	−0.14
8	−0.04	−0.05	57	+0.17	−1.68
9	+0.57	+0.38	58	+0.15	+0.04
12	−0.08	−0.11	62	+0.37	−0.13
13	−0.01	+0.50	64	−0.19	−0.33
14	−0.38	+0.45	67	+0.14	−0.14
15	−0.05	+0.71	71	+0.51	−0.76
24	−0.08	+1.00	72	−0.74	+0.58
25	+0.18	−0.16	76	−0.20	+0.44
29	+0.06	−0.02	78	+0.41	−0.58
30	+1.10	−0.16	80	0.00	+0.14
32	+0.43	+0.05	81	+0.29	+0.13
33	−1.73	+0.49	84	+0.11	+0.38
34	−0.47	−0.01	85	+0.13	−1.19
37	+0.43	−1.31	89	−0.06	−0.46
39	+.017	−0.60	92	−0.30	+0.43
40	+0.70	−0.09	95	+0.06	−0.44
41	+1.36	+0.41			

TABLE VIII.—γ CYGNI FINAL COÖRDINATES.

Star.	*X*	*Y*	Star.	*X*	*Y*
	″	″		″	″
1	−2877.17	−1077.04	49	+ 361.90	+1188.81
2	−2780.62	+1764.80	50	+ 375.72	+1645.13
3	−2821.34	−2420.97	51	+ 379.34	+2011.46
4	−2765.16	− 431.94	52	+ 394.47	+2771.05
5	−2755.55	−1285.86	53	+ 469.59	+ 721.14
6	−2681.91	−1474.63	54	+ 493.37	+ 936.18
7	−2627.21	+ 522.91	55	+ 566.83	+2283.64
8	−2449.66	− 62.02	56	+ 577.78	+1238.06
9	−2333.76	−1772.33	57	+ 601.02	+1265.18
10	−1880.78	+ 770.53	58	+ 624.69	+1949.40
11	−1822.62	−1210.90	59	+ 640.96	+ 224.68
12	−1631.70	−2492.68	60	+ 642.82	+2141.56
13	−1585.99	−2229.00	61	+ 670.05	+1821.20
14	−1411.91	−3046.95	62	+ 677.86	+2218.61
15	−1290.96	−2239.98	63	+ 754.90	+1763.55
16	−1236.58	+ 360.20	64	+ 757.33	+1800.60
17	−1195.78	− 807.08	65	+ 789.29	− 369.85
18	−1191.82	−1402.51	66	+ 793.29	+1716.31
19	−1176.25	−1439.60	67	+ 953.87	−2187.62
20	−1164.76	− 442.52	68	+ 981.26	+1528.55
21	−1158.14	−2456.47	69	+1027.91	+1719.83
22	−1081.97	−1538.27	70	+1209.29	− 467.11
23	−1031.07	+ 937.32	71	+1229.09	−2587.01
24	−1004.91	−2297.19	72	+1262.48	+ 285.52
25	− 940.42	−2804.19	73	+1410.68	+ 833.67
26	− 908.49	− 154.05	74	+1437.21	+1393.27
27	− 815.16	−1662.74	75	+1499.10	−1569.87
28	− 785.35	−1294.76	76	+1547.86	+2063.26
29	− 697.99	−2317.06	77	+1715.04	− 607.27
30	− 610.60	+1967.48	78	+1773.29	− 388.24
31	− 574.22	−1600.17	79	+1769.50	+ 551.90
32	− 490.58	−1530.60	80	+1882.13	−1519.03
33	− 417.85	+ 691.44	81	+2073.08	− 872.15
34	− 422.70	−2919.45	82	+2157.37	− 160.80
35	− 365.84	+ 477.30	83	+2181.86	+1504.08
36	− 354.12	+2150.50	84	+2224.18	−1686.22
37	− 344.68	− 253.37	85	+2247.07	− 591.43
38	− 268.41	+1030.94	86	+2330.15	− 260.23
39	− 240.01	−2867.37	87	+2412.22	− 702.80
40	− 152.23	−1523.57	88	+2502.32	− 422.51
41	− 99.82	+1745.48	89	+2493.21	+1210.78
42	− 69.13	+ 705.85	90	+2526.12	− 882.41
43	− 58.08	+2625.92	91	+2521.02	+1148.46
44	− 33.59	−1902.68	92	+2635.70	+ 501.86
45	+ 0.54	+ 0.23	93	+2691.02	− 264.68
46	+ 29.52	−1655.98	94	+3004.95	+ 762.72
47	+ 110.61	− 485.96	95	+3091.63	+ 305.25
48	+ 255.01	−1039.98			

TABLE IX.—γ CYGNI DIAMETERS OF STAR-IMAGES.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r		r
1	0.171	25	0.147	49	0.124	73	0.121
2	0.333	26	0.105	50	0.164	74	0.142
3	0.201	27	0.131	51	0.143	75	0.127
4	0.185	28	0.109	52	0.193	76	0.146
5	0.177	29	0.140	53	0.114	77	0.131
6	0.185	30	0.172	54	0.118	78	0.151
7	0.177	31	0.120	55	0.138	79	0.114
8	0.148	32	0.108	56	0.121	80	0.165
9	0.151	33	0.116	57	0.128	81	0.167
10	0.132	34	0.157	58	0.155	82	0.125
11	0.109	35	0.125	59	0.114	83	0 140
12	0.154	36	0.129	60	0.127	84	0.211
13	0.142	37	0.127	61	0.122	85	0.153
14	0.274	38	0.125	62	0.143	86	0.119
15	0.131	39	0.128	63	0.127	87	0.148
16	0.106	40	0.121	64	0.174	88	0.127
17	0.104	41	0.129	65	0.116	89	0.158
18	0.120	42	0.130	66	0.140	90	0.147
19	0.124	43	0.181	67	0.146	91	0.131
20	0.114	44	0.129	68	0.143	92	0.237
21	0.117	45	0.554	69	0.135	93	0.128
22	0.144	46	0.129	70	0.120	94	0.167
23	0.131	47	0.109	71	0.193	95	0.192
24	0.136	48	0.120	72	0.128		

TABLE X.—γ CYGNI FINAL CATALOG.

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Preces-sion.	Secular Varia-tion.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	8.0	6	20 13 35.821	303 23 57.31	+2.1504	+32.2559	+0.0018	+0.0263	39 33 13.30	+11.0392	+0.2571	1876.09
2	5.7	3	20 13 41.381	303 25 20.72	2.1245	31.8671	0.0017	0.0253	40 20 35.74	11.0460	0.2538	76.55
3	7.4	3	20 13 41.960	303 25 29.40	2.1628	32.4423	0.0018	0.0268	39 10 50.32	11.0467	0.2585	76.10
4	7.7	7	20 13 44.879	303 26 13.19	2.1449	32.1734	0.0017	0.0261	39 43 59.56	11.0503	0.2563	76.01
5	7.8	7	20 13 46.533	303 26 38.00	2.1527	32.2912	0.0018	0.0264	39 29 45.89	11.0523	0.2572	76.01
6	7.7	7	20 13 53.071	303 28 16.06	+2.1547	+32.3212	+0.0018	+0.0266	39 26 37.95	+11.0602	+0.2574	76.01
7	7.8	4	20 13 55.954	303 28 59.31	2.1366	32.0492	0.0017	0.0259	39 59 55.77	11.0637	0.2551	76.02
8	8.4	7	20 14 11.906	303 32 58.59	2.1427	32.1403	0.0018	0.0263	39 50 12.75	11.0832	0.2557	76.01
9	8.4	7	20 14 23.359	303 35 50.39	2.1587	32.3811	0.0018	0.0270	39 21 43.79	11.0970	0.2574	76.01
10	8.8	4	20 15 0.738	303 45 11.07	2.1372	32.0581	0.0018	0.0264	40 4 10.21	11.1424	0.2544	75.61
11	9.5	3	20 15 7.071	303 46 46.07	+2.1556	+32.3335	+0.0018	+0.0272	39 31 9.37	+11.1501	+0.2565	75.55
12	8.3	3	20 15 24.293	303 51 4.40	2.1679	32.5179	0.0018	0.0277	39 9 49.09	11.1709	0.2578	75.63
13	8.6	7	20 15 28.079	303 52 1.18	2.1657	32.4849	0.0018	0.0277	39 14 13.00	11.1756	0.2574	76.01
14	6.4	6	20 15 43.457	303 55 51.86	2.1736	32.6047	0.0019	0.0281	39 0 36.26	11.1942	0.2582	75.86
15	8.9	7	20 15 53.475	303 58 22.12	2.1669	32.5030	0.0019	0.0279	39 14 3.71	11.2063	0.2572	76.01
16	9.6	3	20 15 57.033	303 59 15.50	+2.1435	+32.1523	+0.0018	+0.0271	39 57 24.00	+11.2106	+0.2544	75.55
17	9.6	4	20 16 1.071	304 0 16.07	2.1543	32.3144	0.0018	0.0275	39 37 56.95	11.2155	0.2556	75.61
18	9.2	6	20 16 1.661	304 0 24.92	2.1597	32.3955	0.0018	0.0277	39 28 1.58	11.2162	0.2563	75.86
19	9.0	4	20 16 3.021	304 0 45.32	2.1601	32.4014	0.0019	0.0278	39 27 24.57	11.2178	0.2563	75.61
20	9.3	4	20 16 3.608	304 0 54.12	2.1511	32.2665	0.0018	0.0274	39 44 1.65	11.2185	0.2552	75.61
21	9.2	3	20 16 4.992	304 1 14.88	+2.1693	+32.5397	+0.0019	+0.0281	39 10 27.90	+11.2202	+0.2574	75.55
22	8.6	3	20 16 11.197	304 2 47.96	2.1614	32.4203	0.0019	0.0279	39 25 46.32	11.2277	0.2564	75.55
23	8.9	6	20 16 14.696	304 3 40.44	2.1390	32.0850	0.0018	0.0270	40 7 2.04	11.2319	0.2536	76.05
24	8.8	6	20 16 18.113	304 4 31.69	2.1685	32.5270	0.0019	0.0282	39 13 7.80	11.2361	0.2571	76.09
25	8.5	7	20 16 23.825	304 5 57.38	2.1732	32.5986	0.0019	0.0284	39 4 41.14	11.2429	0.2576	76.01

TABLE X. —γ CYGNI FINAL CATALOG. —*Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
26	9.6	6	20 16 25.731	304 6 25.97	+2.1495	+32.2421	+0.0018	+0.0276	39 48 51.18	+11.2453	+0.2547	1875.86
27	8.9	3	20 16 34.260	304 8 33.90	2.1635	32.4524	0.0019	0.0281	39 23 42.88	11.2556	0.2563	75.55
28	9.5	3	20 16 36.731	304 9 10.97	2.1603	32.4044	0.0019	0.0280	39 29 50.92	11.2586	0.2559	75.55
29	8.6	7	20 16 44.526	304 11 7.89	2.1698	32.5471	0.0019	0.0284	39 12 48.98	11.2680	0.2569	76.01
30	7.9	7	20 16 51.126	304 12 46.89	2.1312	31.9677	0.0018	0.0270	40 24 13.54	11.2759	0.2522	76.01
31	9.2	7	20 16 55.032	304 13 45.48	+2.1639	+32.4578	+0.0019	+0.0283	39 24 46.10	+11.2806	+0.2561	76.01
32	9.5	7	20 17 2.237	304 15 33.55	2.1636	32.4533	0.0019	0.0284	39 25 55.85	11.2894	0.2559	76.01
33	9.3	7	20 17 8.189	304 17 2.84	2.1437	32.1554	0.0018	0.0276	40 2 57.98	11.2965	0.2534	76.01
34	8.2	7	20 17 8.299	304 17 4.49	2.1762	32.6434	0.0019	0.0288	39 2 47.29	11.2966	0.2574	76.01
35	9.0	4	20 17 12.747	304 18 11.20	2.1459	32.1879	0.0019	0.0278	39 59 23.92	11.3020	0.2537	75.61
36	8.9	3	20 17 13.557	304 18 23.35	+2.1305	+31.9579	+0.0018	+0.0271	40 27 17.06	+11.3029	+0.2518	75.55
37	9.0	7	20 17 14.677	304 18 40.15	2.1526	32.2889	0.0019	0.0280	39 47 13.29	11.3043	0.2544	76.01
38	9.0	6	20 17 21.172	304 20 17.58	2.1412	32.1178	0.0018	0.0276	40 8 37.69	11.3122	0.2530	76.05
39	9.0	3	20 17 23.975	304 20 59.63	2.1765	32.6468	0.0019	0.0290	39 3 39.60	11.3155	0.2572	75.55
40	9.1	7	20 17 31.440	304 22 51.60	2.1648	32.4721	0.0019	0.0286	39 26 3.31	11.3245	0.2557	76.01
41	8.9	3	20 17 35.849	304 23 57.74	+2.1353	+32.0296	+0.0018	+0.0275	40 20 32.32	+11.3298	+0.2521	75.55
42	8.9	7	20 17 38.559	304 24 38.39	2.1450	32.1743	0.0019	0.0279	40 3 12.74	11.3330	0.2532	76.01
43	7.8	7	20 17 39.481	304 24 52.22	2.1273	31.9101	0.0018	0.0272	40 35 12.67	11.3342	0.2511	76.01
44	8.9	7	20 17 41.685	304 25 25.28	2.1687	32.5299	0.0019	0.0288	39 19 44.27	11.3368	0.2560	76.01
45	4.0	7	20 17 44.627	304 26 9.40	2.1517	32.2749	0.0019	0.0282	39 51 27.13	11.3403	0.2539	76.01
46	8.9	3	20 17 47.127	304 26 46.90	+2.1667	+32.5005	+0.0019	+0.0288	39 23 50.95	+11.3434	+0.2557	75.55
47	9.5	3	20 17 54.167	304 28 32.51	2.1565	32.3475	0.0019	0.0285	39 43 20.91	11.3519	0.2544	75.55
48	9.2	7	20 18 6.634	304 31 39.51	2.1621	32.4309	0.0019	0.0288	39 34 6.79	11.3668	0.2549	76.01
49	9.0	7	20 18 16.161	304 34 2.42	2.1423	32.1345	0.0019	0.0281	40 11 15.43	11.3782	0.2524	76.01
50	8.1	7	20 18 17.429	304 34 21.43	2.1382	32.0725	0.0019	0.0280	40 18 51.71	11.3797	0.2519	76.01

TABLE X.—γ CYGNI FINAL CATALOG.—*Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
51	8.6	3	20 18 17.795	304 34 26.92	+2.1348	+32.0224	+0.0019	+0.0278	40 24 58.00	+11.3802	+0.2514	1875.55
52	7.6	6	20 18 19.227	304 34 48.40	2.1279	31.9182	0.0018	0.0275	40 37 37.46	11.3819	0.2506	75.86
53	9.3	3	20 18 25.481	304 36 22.22	2.1470	32.2049	0.0019	0.0284	40 3 27.59	11.3894	0.2528	75.55
54	9.2	4	20 18 27.591	304 36 53.86	2.1451	32.1770	0.0019	0.0283	40 7 2.58	11.3920	0.2526	75.61
55	8.7	3	20 18 34.266	304 38 33.99	2.1331	31.9964	0.0019	0.0279	40 29 29.78	11.4000	0.2510	75.55
56	9.1	6	20 18 35.011	304 38 45.16	+2.1427	+32.1410	+0.0019	+0.0283	40 12 4.26	+11.4009	+0.2522	75.86
57	9.0	7	20 18 37.045	304 39 15.68	2.1426	32.1387	0.0019	0.0283	40 12 31.32	11.4034	0.2521	76.01
58	8.3	7	20 18 39.263	304 39 48.95	2.1364	32.0462	0.0019	0.0281	40 23 55.44	11.4060	0.2514	76.01
59	9.3	3	20 18 40.296	304 40 4.44	2.1522	32.2829	0.0019	0.0287	39 55 10.75	11.4072	0.2532	75.55
60	9.0	6	20 18 40.894	304 40 13.41	2.1347	32.0207	0.0019	0.0280	40 27 7.53	11.4079	0.2511	75.86
61	9.1	4	20 18 43.203	304 40 48.05	+2.1378	+32.0666	+0.0019	+0.0282	40 21 47.12	+11.4107	+0.2515	75.61
62	8.6	7	20 18 43.983	304 40 59.74	2.1342	32.0124	0.0019	0.0280	40 28 24.47	11.4117	0.2510	76.01
63	9.0	4	20 18 50.611	304 42 39.17	2.1387	32.0798	0.0019	0.0283	40 20 49.23	11.4196	0.2515	75.61
64	7.9	6	20 18 50.833	304 42 42.50	2.1383	32.0748	0.0019	0.0282	40 21 26.27	11.4198	0.2514	75.86
65	9.3	5	20 18 53.023	304 43 15.35	2.1582	32.3724	0.0019	0.0291	39 45 15.79	11.4225	0.2538	75.87
66	8.6	3	20 18 53.955	304 43 29.33	+2.1392	+32.0886	+0.0019	+0.0283	40 20 1.87	+11.4236	+0.2515	75.55
67	8.5	7	20 19 6.691	304 46 40.37	2.1751	32.6258	0.0020	0.0298	39 14 57.56	11.4388	0.2556	76.01
68	8.6	4	20 19 10.329	304 47 34.93	2.1417	32.1261	0.0019	0.0286	40 16 53.44	11.4432	0.2516	75.61
69	8.8	4	20 19 14.475	304 48 37.12	2.1402	32.1027	0.0019	0.0285	40 20 4.52	11.4482	0.2513	75.61
70	9.2	7	20 19 29.401	304 52 21.02	2.1607	32.4110	0.0020	0.0295	39 43 36.84	11.4661	0.2536	76.01
71	7.6	6	20 19 30.214	304 52 33.21	+2.1797	+32.6950	+0.0020	+0.0301	39 8 17.04	+11.4670	+0.2559	76.09
72	9.0	6	20 19 34.345	304 53 35.18	2.1542	32.3127	0.0020	0.0293	39 56 9.19	11.4719	0.2527	76.05
73	9.1	5	20 19 47.504	304 56 52.56	2.1498	32.2476	0.0019	0.0292	40 5 16.50	11.4877	0.2520	75.87
74	8.6	7	20 19 50.101	304 57 31.51	2.1449	32.1730	0.0019	0.0290	40 14 35.91	11.4908	0.2514	76.01
75	9.0	4	20 19 53.945	304 58 29.18	2.1717	32.5760	0.0020	0.0301	39 25 12.58	11.4954	0.2546	75.61

TABLE X. — γ CYGNI FINAL CATALOG. — *Concluded.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
76	8.5	7	20 20 0.133	305 0 2.00	+2.1392	+32.0884	+0.0019	+0.0289	40 25 45.15	+11.5028	+0.2506	1876.01
77	8.9	5	20 20 13.154	305 3 17.31	2.1640	32.4606	0.0020	0.0300	39 41 13.72	11.5183	0.2534	75.87
78	8.4	7	20 20 18.335	305 4 35.03	2.1623	32.4349	0.0020	0.0300	39 44 52.32	11.5245	0.2531	76.01
79	9.3	3	20 20 18.592	305 4 38.88	2.1539	32.3081	0.0020	0.0296	40 0 32.43	11.5248	0.2521	75.55
80	8.1	7	20 20 27.029	305 6 45.44	2.1728	32.5924	0.0020	0.0304	39 26 0.84	11.5349	0.2543	76.01
81	8.0	7	20 20 43.975	305 10 59.62	+2.1679	+32.5180	+0.0020	+0.0304	39 36 46.13	+11.5551	+0.2534	76.01
82	9.0	6	20 20 51.806	305 12 57.09	2.1619	32.4280	0.0020	0.0302	39 48 36.69	11.5644	0.2526	75.86
83	8.6	7	20 20 55.215	305 13 48.23	2.1470	32.2049	0.0020	0.0297	40 16 21.18	11.5685	0.2508	76.01
84	7.2	7	20 20 56.420	305 14 6.30	2.1757	32.6353	0.0021	0.0308	39 23 10.88	11.5699	0.2542	76.01
85	8.3	5	20 20 59.250	305 14 48.75	2.1661	32.4912	0.0020	0.0304	39 41 25.32	11.5733	0.2530	76.20
86	9.2	3	20 21 6.717	305 16 40.76	+2.1635	+32.4520	+0.0020	+0.0304	39 46 55.71	+11.5822	+0.2526	75.55
87	8.4	7	20 21 13.462	305 18 21.93	2.1678	32.5163	0.0020	0.0306	39 39 32.41	11.5902	0.2530	76.01
88	9.0	3	20 21 21.508	305 20 22.62	2.1656	32.4844	0.0020	0.0306	39 44 11.77	11.5998	0.2526	75.55
89	8.2	6	20 21 22.155	305 20 32.32	2.1510	32.2644	0.0020	0.0301	40 11 24.94	11.6006	0.2509	76.09
90	8.5	3	20 21 23.165	305 20 47.48	2.1698	32.5471	0.0021	0.0308	39 36 31.69	11.6017	0.2531	75.55
91	8.9	3	20 21 24.524	305 21 7.86	+2.1516	+32.2746	+0.0020	+0.0301	40 10 22.34	+11.6034	+0.2509	75.55
92	6.9	7	20 21 33.925	305 23 28.48	2.1579	32.3690	0.0020	0.0304	39 59 34.63	11.6146	0.2516	76.01
93	9.0	7	20 21 38.012	305 24 30.18	2.1650	32.4751	0.0021	0.0308	39 46 47.60	11.6194	0.2523	76.01
94	8.0	3	20 22 6.325	305 31 34.88	2.1572	32.3574	0.0020	0.0307	40 3 51.21	11.6531	0.2510	75.55
95	7.6	7	20 22 13.374	305 33 20.61	2.1616	32.4242	0.0021	0.0310	39 56 12.75	11.6615	0.2514	76.01

Table I.—Photographs of ν Cygni.

Observatory of L. M. Rutherfurd, New York.

Lat. 40° 43′ 48″.5. Long. $4^h\ 55^m\ 56^s.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Zen. Dist.
				Att.	Ex.	Tel.		
		h m s	in.					°
1	1875 July 30	18 35 42	30.062	77°	76°	78°	7.57	25.8
2	1875 July 30	19 9 12	30.062	77	76	78	7.57	19.5
3	1875 July 30	19 42 48	30.062	77	76	78	7.57	13.2
4	1875 Nov. 11	22 26 52	30.038	43	42	43	7.8	17.8
5	1875 Nov. 11	23 0 12	30.038	43	42	43	7.8	24.1
6	1875 Nov. 11	23 35 12	30.038	43	42	43	7.8	30.5
7	1876 June 22	16 14 2	30.056	68	66	70	7.6	51.3
9	1876 July 14	17 9 22	29.964	80	78	80	7.5	41.5
10	1876 July 14	17 44 12	29.964	80	78	80	7.5	35.2
11	1876 Nov. 12	23 56 18	30.018	46	45	48	7.8	34.4
12	1876 Nov. 12	0 27 12	30.018	46	45	48	7.8	40.0
13	1876 Nov. 12	0 57 48	30.018	46	45	48	7.8	45.5
14	1876 Nov. 16	23 55 28	30.280	41	41	42	7.85	34.3
15	1876 Nov. 16	0 22 32	30.280	41	41	42	7.85	39.2

TABLE II.—ν CYGNI CORRECTED COÖRDINATES.

PLATE 1.			PLATE 2.			PLATE 3.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
3	—45.1007	— 7.2823	3	—45.1333	— 7.0463	3	—45.0970	— 7.2961
4	—44.6949	—32.3295	4	—44.8694	—32.0872	4	—44.6853	—32.3344
5	—40.5900	—30.7340	5	—40.7485	—30.5210	5	—40.5764	—30.7464
7	—40.0187	—17.4317	7	—40.1077	—17.2224	6	—40.1810	+11.3312
11	—36.5117	—31.0552	11	—36.6759	—30.8617	7	—40.0138	—17.4467
12	—28.5410	+43.8357	12	—28.3038	+43.9828	11	—36.5016	—31.0674
13	—28.5888	+28.2589	13	—28.4385	+28.4061	12	—28.5624	+43.8206
14	—28.0685	+12.2756	14	—28.0028	+12.4234	13	—28.6041	+28.2507
15	—26.7253	—18.3805	15	—26.8206	—18.2390	14	—28.0806	+12.2666
16	—23.8886	—58.7105	16	—24.1949	—58.5796	15	—26.7206	—18.3899
19	—15.0330	+27.4693	19	—14.8842	+27.5451	16	—23.8636	—58.7122
20	—11.8294	—34.5330	20	—12.0081	—34.4686	17	—21.5664	+ 2.4128
22	— 0.9752	+ 6.9244	22	— 0.9495	+ 6.9336	19	—15.0462	+27.4607
23	0.0000	0.0000	23	0.0000	0.0000	20	—11.8146	—34.5336
24	— 0.0045	—28.1988	24	— 0.1564	—28.1966	21	— 2.7018	+32.3981
27	+ 3.5240	+35.4590	27	+ 3.7084	+35.4370	22	— 0.9902	+ 6.9256
28	+ 4.8608	—13.2397	28	+ 4.7900	—13.2610	23	0.0000	0.0000
30	+10.0104	+48.0440	29	+ 8.7923	—61.0421	24	+ 0.0122	—28.1976
31	+10.8142	—18.2672	30	+10.2632	+47.9867	25	+ 1.4001	+49.7954
32	+11.1977	—30.6928	31	+10.7148	—18.3216	27	+ 3.5026	+35.4578
33	+12.3047	— 0.2798	32	+11.0295	—30.7478	28	+ 4.8674	—13.2354
34	+16.5097	+12.7473	33	+12.3020	— 0.3492	29	+ 9.1412	—60.9925
35	+16.9986	—32.0844	34	+16.5740	+12.6626	30	+ 9.9826	+48.0426
36	+17.6007	+52.3720	35	+16.8306	—32.1730	31	+10.8182	—18.2630
37	+18.3286	—12.4646	36	+17.8708	+52.2785	32	+11.2044	—30.6845
38	+20.2235	—45.2796	37	+18.2640	—12.5559	33	+12.3019	— 0.2768
39	+20.1464	+32.5949	39	+20.3137	+32.4951	34	+16.4989	+12.7537
41	+29.2916	—14.3718	41	+29.2180	—14.5211	35	+17.0109	—32.0775
42	+33.8361	— 7.8691	42	+33.7963	— 8.0438	36	+17.5707	+52.3790
43	+34.7878	+ 6.5279	43	+34.8180	+ 6.3473	37	+18.3300	—12.4563
45	+42.7389	+32.1750	45	+42.9075	+31.9534	39	+20.1236	+32.6014
46	+44.8069	—33.0942	46	+44.6291	—33.3230	41	+29.2970	—14.3570
48	+54.4853	—37.7122	48	+54.2826	—37.9894	42	+33.8353	— 7.8538
						43	+34.7767	+ 6.5413
						44	+42.5463	+28.0714
						45	+42.7224	+32.1947
						46	+44.8201	—33.0750
						48	+54.5030	—37.6899

Table II.—ν Cygni Corrected Coördinates.—*Continued.*

Plate 4.			Plate 5.			Plate 6.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
1	—60.9665	—10.4896	1	—60.9670	—10.4629	1	—60.9650	—10.4902
2	—45.4454	+13.1174	2	—45.4348	+13.1379	2	—45.4446	+13.1243
3	—45.0809	— 7.2988	3	—45.0738	-- 7.2792	3	—45.0721	— 7.2951
4	—44.6656	—32.3330	4	—44.6755	—32.3162	4	—44.6589	—32.3342
5	—40.5539	—30.7453	5	—40.5564	—30.7271	5	—40.5471	—30.7435
6	—40.1665	+11.3322	6	—40.1568	+11.3501	6	—40.1658	+11.3367
7	—39.9909	—17.4416	7	—39.9922	—17.4288	7	—39.9845	—17.4423
8	—38.5712	—25.4020	8	—38.5746	—25.3892	8	—38.5664	—25.4002
9	—38.0658	+ 0.8575	9	—38.0587	+ 0.8719	9	—38.0624	+ 0.8640
10	—37.5989	—21.8714	10	—37.5972	—21.8596	10	—37.5972	—21.8756
11	—36.4840	—31.0688	11	—36.4844	—31.0565	11	—36.4761	—31.0668
12	—28.5426	+43.8289	12	—28.5208	+43.8424	12	—28.5490	+43.8332
13	—28.5877	+28.2544	13	—28.5685	+28.2676	13	—28.5887	+28.2571
14	—28.0606	+12.2709	14	—28.0478	+12.2818	14	—28.0588	+12.2730
15	—26.7004	—18.3846	15	—26.6974	—18.3746	15	—26.6942	—18.3806
16	—23.8442	—58.7168	16	—23.8579	—58.7092	16	—23.8345	—58.7117
17	—21.5409	+ 2.4131	17	—21.5408	+ 2.4252	17	—21.5408	+ 2.4206
18	—20.8731	—54.4299	18	—20.8818	—54.4259	18	—20.8587	—54.4265
19	—15.0251	+27.4651	19	—15.0066	+27.4750	19	—15.0250	+27.4751
20	—11.7979	—34.5304	20	—11.8002	—34.5276	20	—11.7902	—34.5219
21	— 2.6830	+32.4065	21	— 2.6636	+32.4102	21	— 2.6839	+32.4112
22	— 0.9710	+ 6.9333	22	— 0.9570	+ 6.9330	22	— 0.9701	+ 6.9399
23	0.0000	0.0000	23	0.0000	0.0000	23	0.0000	0.0000
24	+ 0.0255	—28.1906	24	+ 0.0244	—28.1897	24	+ 0.0295	—28.1828
25	+ 1.4202	+49.8054	25	+ 1.4472	+49.8030	25	+ 1.4162	+49.8128
26	+ 2.1691	—21.9275	26	+ 2.1703	—21.9253	26	+ 2.1721	—21.9192
27	+ 3.5220	+35.4656	27	+ 3.5382	+35.4629	27	+ 3.5159	+35.4695
28	+ 4.8825	—13.2235	28	+ 4.8870	—13.2270	28	+ 4.8863	—13.2169
29	+ 9.1629	—60.9898	30	+10.0234	+48.0531	29	+ 9.1667	—60.9799
30	+10.0005	+48.0626	31	+10.8396	—18.2566	30	+ 9.9914	+48.0670
31	+10.8414	—18.2518	32	+11.2223	—30.6850	31	+10.8403	—18.2458
32	+11.2279	—30.6778	33	+12.3286	— 0.2715	32	+11.2310	—30.6686
33	+12.3218	— 0.2689	34	+16.5270	+12.7568	33	+12.3233	— 0.2607
34	+16.5181	+12.7649	35	+17.0285	—32.0766	34	+16.5141	+12.7728
35	+17.0347	—32.0674	36	+17.6122	+52.3758	35	+17.0373	—32.0604
36	+17.5849	+52.3836	37	+18.3542	—12.4511	36	+17.5731	+52.3886
37	+18.3522	—12.4448	38	+20.2484	—45.2665	37	+18.3506	—12.4374
38	+20.2575	—45.2602	39	+20.1561	+32.6075	38	+20.2611	—45.2449
39	+20.1379	+32.6165	40	+25.2430	— 1.3706	39	+20.1351	+32.6239
40	+25.2394	— 1.3655	41	+29.3180	—14.3621	40	+25.2362	— 1.3558
41	+29.3177	—14.3484	42	+33.8579	— 7.8612	41	+29.3158	—14.3377
42	+33.8566	— 7.8449	43	+34.8034	+ 6.5371	42	+33.8574	— 7.8341
43	+34.7926	+ 6.5512	44	+42.5871	+28.0691	43	+34.7928	+ 6.5614
44	+42.5706	+28.0800	45	+42.7569	+32.1886	45	+42.7297	+32.2184
45	+42.7397	+32.2026	46	+44.8340	—33.0787	46	+44.8403	—33.0488
46	+44.8411	—33.0622	47	+49.9676	+16.3430	48	+54.5265	—37.6690
47	+49.9516	+16.3579	48	+54.5156	—37.7010			
48	+54.5200	—37.6811						

TABLE II.—ν CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 7.			PLATE 9.			PLATE 10.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
3	−45.0845	− 7.2726	3	−45.0886	− 7.2719	3	−45.0832	− 7.2959
4	−44.7010	−32.3104	5	−40.5925	−30.7176	5	−40.5710	−30.7416
5	−40.5836	−30.7268	7	−40.0162	−17.4174	7	−40.0016	−17.4417
7	−40.0100	−17.4198	11	−36.5173	−31.0411	11	−36.4936	−31.0594
11	−36.5098	−31.0429	12	−28.5136	+43.8357	12	−28.5554	+43.8202
14	−28.0629	+12.2814	13	−28.5728	+28.2656	13	−28.5962	+28.2506
16	−23.8950	−58.6947	14	−28.0602	+12.2801	14	−28.0716	+12.2693
20	−11.8355	−34.5191	15	−26.7298	−18.3693	16	−23.8589	−58.6983
22	− 0.9844	+ 6.9306	16	−23.9014	−58.6947	19	−15.0419	+27.4604
23	0.0000	0.0000	20	−11.8380	−34.5210	20	−11.8159	−34.5257
27	+ 3.5274	+35.4526	22	− 0.9812	+ 6.9234	22	− 0.9940	+ 6.9323
28	+ 4.8503	−13.2277	23	0.0000	0.0000	23	0.0000	0.0000
30	+10.0176	+48.0446	25	+ 1.4396	+49.7902	27	+ 3.5000	+35.4605
31	+10.8059	−18.2586	27	+ 3.5301	+35.4482	29	+ 9.1404	−60.9779
32	+11.1753	−30.6815	28	+ 4.8568	−13.2364	31	+10.8178	−18.2538
33	+12.3019	− 0.2801	29	+ 9.0914	−60.9919	32	+11.2084	−30.6756
34	+16.5070	+12.7500	31	+10.8052	−18.2648	33	+12.2974	− 0.2684
35	+16.9833	−32.0762	32	+11.1782	−30.6880	34	+16.4944	+12.7593
36	+17.6019	+52.3649	33	+12.2975	− 0.2864	35	+17.0092	−32.0652
37	+18.3133	−12.4538	34	+16.5042	+12.7409	36	+17.5707	+52.3782
38	+20.2020	−45.2650	35	+16.9825	−32.0844	41	+28.2905	−14.3460
39	+20.1410	+32.5982	36	+17.6060	+52.3593	42	+33.8288	− 7.8447
41	+29.2788	−14.3632	41	+29.2786	−14.3723	45	+42.7116	+32.2036
42	+33.8262	− 7.8678	42	+33.8179	− 7.8788	46	+44.8067	−33.0581
45	+42.7246	+32.1757	45	+42.7342	+32.1629	48	+54.4870	−37.6738
48	+54.4566	−37.7010	46	+44.7834	−33.0975			
			48	+54.4570	−37.7206			

TABLE II. — ν CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 11.			PLATE 12.			PLATE 13		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
3	—45.0670	— 7.3141	1	—60.9559	—10.4918	3	—45.0654	— 7.3101
5	—40.5380	—30.7579	2	—45.4443	+13.1216	4	—44.6324	—32.3458
6	—40.1644	+11.3167	3	—45.0690	— 7.2998	5	—40.5252	—30.7557
7	—39.9751	—17.4575	4	—44.6518	—32.3318	6	—40.1663	+11.3220
11	—36.4601	—31.0789	5	—40.5403	—30.7439	7	—39.9719	—17.4531
12	—28.5632	+43.8214	6	—40.1585	+11.3332	11	—36.4562	—31.0806
13	—28 5946	+28.2501	7	—39.9815	—17.4438	12	—28.5677	+43.8228
14	—28.0594	+12.2602	11	—36.4684	—31.0696	13	—28.5999	+28.2476
15	—26.6877	—18.3928	12	—28.5486	+43.8325	14	—28.0604	+12.2634
16	—23.8156	—58.7188	13	—28.5888	+28.2599	15	—26.6814	—18.3911
19	—15.0360	+27.4636	14	—28.0556	+12.2740	16	—23.8001	—58.7196
20	—11.7744	—34.5276	15	—26.6862	—18.3819	19	—15.0378	+27.4682
22	— 0.9701	+ 6.9376	16	—23.8228	—58.7118	20	—11.7671	—34.5262
23	0.0000	0.0000	17	—21.5385	+ 2.4224	21	— 2.6992	+32.4143
27	+ 3.5043	+35.4693	19	—15.0282	+27.4720	22	— 0.9712	+ 6.9376
29	+ 9.1904	- 60.9769	20	—11.7809	—34.5227	23	0.0000	0.0000
30	+ 9.9788	+48.0680	22	— 0.9708	+ 6.9406	24	+ 0.0460	—28.1850
31	+10.8499	—18.2424	23	0.0000	0.0000	25	+ 1.3886	+49.8169
32	+11.2456	—30.6699	24	+ 0.0345	—28.1830	27	+ 3.4953	+35.4709
33	+12.3246	— 0.2562	25	+ 1.4094	+49.8132	28	+ 4.8980	—13.2145
34	+16.5150	+12.7760	27	+ 3.5156	+35.4706	29	+ 9.1986	—60.9758
35	+17.0490	—32.0576	28	+ 4.8916	—13.2148	30	+ 9.9649	+48.0675
36	+17.5639	+52.3966	29	+ 9.1734	—60.9772	31	+10.8520	—18.2427
37	+18.3558	—12.4308	30	+ 9.9864	+48.0710	32	+11.2448	—30.6674
41	+29.3243	—14.3300	31	+10.8471	—18.2453	34	+16.5064	+12.7760
46	+44.8580	—33.0370	32	+11.2360	—30.6679	35	+17.0504	—32.0557
48	+54.5454	—37.6566	33	+12.3227	— 0.2597	36	+17.5456	+52.3950
			34	+16.5141	+12.7723	37	+18.3537	—12.4330
			35	+17.0379	—32.0622	38	+20.2823	—45.2395
			36	+17.5704	+52.3916	39	+20.1124	+32.6347
			37	+18.3545	—12.4345	41	+29.3205	—14.3324
			38	+20.2640	—45.2460	42	+33.8565	— 7.8262
			39	+20.1296	+32.6241	43	+34.7859	+ 6.5673
			41	+29.3169	—14.3354	45	+42.7134	+32.2312
			42	+33.8537	— 7.8365	46	+44.8485	—33.0362
			43	+34.7846	+ 6.5624	48	+54.5336	—37.6496
			45	+42.7280	+32.2189			
			46	+44.8444	—33.0516			
			47	+49.9412	+16.3701			
			48	+54.5281	—37.6669			

TABLE II.—ν CYGNI CORRECTED COÖRDINATES. — *Concluded.*

PLATE 14.			PLATE 14.			PLATE 15.		
Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
1	—60.9438	—10.5227	34	+16.5064	+12.7798	16	—23.8065	—58.7226
2	—45.4420	+13.0991	35	+17.0581	—32.0514	19	—15.0371	+27.4653
3	—45.0580	— 7.3196	36	+17.5448	+52.3989	20	—11.7727	—34.5305
4	—44.6275	—32.3582	37	+18.3643	—12.4257	21	— 2.6960	+32.4100
5	—40.5210	—30.7642	38	+20.2940	—45.2296	22	— 0.9700	+ 6.9368
6	—40.1671	+11.3113	39	+20.1155	+32.6323	23	0.0000	0.0000
7	—39.9655	—17.4654	41	+29.3292	—14.3230	24	+ 0.0459	—28.1854
11	—36.4469	—31.0869	42	+33.8623	— 7.8190	25	+ 1.3956	+49.8117
12	—28.5720	+43.8130	43	+34.7885	+ 6.5792	27	+ 3.5029	+35.4692
13	—28.6010	+28.2434	44	+42.5400	+28.1178	28	+ 4.8948	—13.2198
14	—28.0589	+12.2552	45	+42.7112	+32.2380	29	+ 9.1990	—60.9808
15	—26.6746	—18.3960	46	+44.8622	—33.0246	30	+ 9.9736	+48.0698
16	—23.7860	—58.7249	48	+54.5481	—37.6388	31	+10.8532	—18.2472
17	—21.5394	+ 2.4106				32	+11.2456	—30.6696
19	—15.0409	+27.4629		PLATE 15.		33	+12.3244	— 0.2590
20	—11.7578	—34.5306				34	+16.5126	+12.7756
21	— 2.7028	+32.4126	1	—60.9546	—10.5195	35	+17.0526	—32.0582
22	— 0.9686	+ 6.9418	2	—45.4495	+13.1001	36	+17.5562	+52.3930
23	0.0000	0.0000	3	—45.0662	— 7.3211	37	+18.3610	—12.4310
24	+ 0.0546	—28.1818	4	—44.6435	—32.3566	38	+20.2884	—45.2382
25	+ 1.3848	+49.8139	5	—40.5320	—30.7609	39	+20.1224	+32.6314
27	+ 3.4917	+35.4687	6	—40.1709	+11.3171	41	+29.3248	—14.3283
28	+ 4.8942	—13.2182	7	—39.9755	—17.4627	42	+33.8653	— 7.8258
29	+ 9.2133	—60.9748	11	—36.4588	—31.0852	43	+34.7900	+ 6.5726
30	+ 9.9610	+48.0722	12	—28.5615	+43.8135	45	+42.7231	+ 32.2322
31	+10.8584	—18.2397	13	—28.5973	+28.2465	46	+44.8530	—33.0364
32	+11.2532	—30.6647	14	—28.0611	+12.2594	48	+54.5439	—37.6504
33	+12.3254	— 0.2549	15	—26.6804	—18.3972			

Table III.—ν Cygni Refraction Coefficients.

Plate.	M_x	N_x	M_y	N_y
1	+0.000334	+0.000099	—0.000123	+0.000276
2	+ .000306	+ .000077	— .000087	+ .000274
3	+ .000288	+ .000053	— .000056	+ .000273
4	+ .000322	— .000076	+ .000084	+ .000293
5	+ .000348	— .000100	+ .000121	+ .000294
6	+ .000388	— .000121	+ .000167	+ .000298
7	+ .000637	+ .000109	— .000434	+ .000352
9	+ .000461	+ .000129	— .000261	+ .000294
10	+ .000396	+ .000123	— .000194	+ .000281
11	+ .000416	— .000129	+ .000200	+ .000300
12	+ .000474	— .000138	+ .000260	+ .000310
13	+ .000550	— .000135	+ .000337	+ .000329
14	+ .000422	— .000131	+ .000202	+ .000305
15	+ .000472	— .000139	+ .000254	+ .000313

TABLE IV.—ν CYGNI PLATE CONSTANTS.

Plate.	*p*	*r*	Probable Error of *p* or *r*.	*k*	*c*	Probable Error of *k* or *c*.	Probable Error of One Equation.
1	—0.000052	—0.000265	±0.000013	+0″.452	+0″.362	±0″.028	±0″.1097
2	+ .000035	— .005441	.000014	+ .549	+ .311	.030	.1181
3	+ .000006	+ .000229	.000013	+ .635	+ .290	.028	.1121
4	— .000040	+ .000451	.000009	— .294	+ .003	.019	.0733
5	— .000040	+ .000109	.000012	— .656	+ .051	.026	.1028
6	— .000012	+ .000648	.000009	— .301	— .284	.020	.0788
7	+ .000046	— .000549	.000014	+ .584	+ .088	.031	.1222
9	+ .000114	— .000611	.000012	+ .612	+ .344	.027	.1057
10	+ .000135	+ .000162	.000014	+ .619	+ .003	.031	.1226
11	— .000053	+ .000980	.000012	— .473	— .202	.026	.1028
12	— .000043	+ .000772	.000010	— .397	— .295	.022	.0866
13	— .000054	+ .001131	.000017	— .338	— .316	.036	.1412
14	+ .000031	+ .001283	.000013	— .551	— .233	.029	.1136
15	— .000069	+ .001104	.000011	— .433	— .123	.023	.0896

TABLE V.—ν CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.

Star.	X_m	1	2	3	4	5	6	7	9	10	11	12	13	14	15
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
1	—3224.88				+.17	—.10	—.14					.00		+.13	—.06
2	—2403.51				+.10	—.02	+.02					—.13		+.15	—.14
3	—2384.43	—.20	+.06	—.03	—.11	—.01	+.07	—.06	+.03	+.12	+.07	—.05	—.09	+.12	+.01
4	—2363.21	+.25	—.20	+.16	+.14	—.19	.00	—.41				—.03	+.29	+.16	—.12
5	—2145.77	—.10	—.04	+.04	+.18	+.21	+.08	—.05	—.20	—.20	—.11	+.04	+.18	+.02	—.02
6	—2124.32			+.13	+.05	—.07	—.03				+.10	+.20	—.06	—.13	—.23
7	—2115.67	—.11	—.06	—.11	+.12	—.04	+.11	—.12	—.16	+.02	+.17	—.04	+.06	+.12	.00
8	—2040.72				+.09	—.02	—.07								
9	—2013.41				+.03	—.03	+.01								
10	—1989.20				+.07	+.16	—.22								
11	—1930.30	+.12	—.06	+.06	—.06	+.10	—.08	+.02	—.07	+.01	+.08	—.04	—.07	+.04	—.07
12	—1509.06	—.26	+.21	—.19	+.16	+.07	+.02		+.17	—.18	—.13	+.12	—.09	—.10	+.21
13	—1511.61	—.11	+.05	—.08	+.02	+.07	+.05		—.01	—.02	+.06	+.02	—.07	—.03	+.07
14	—1484.05	—.01	+.10	—.20	+.02	+.05	+.06	—.36	—.04	—.08	+.09	+.13	+.07	+.11	+.06
15	—1412.69	—.07	—.08	—.09	—.01	+.10	+.03		—.24		—.10	+.16	+.03	+.09	+.16
16	—1262.41	+.03	—.03	+.14	—.04	—.03	—.12	+.17	+.12	+.06	—.28	—.01	+.05	+.15	—.17
17	—1139.66			—.23	+.23	—.21	+.14					+.11		—.05	
18	—1105.11				—.13	+.06	+.08								
19	— 794.45	—.35	—.01	—.23	+.10	+.16	+.25			—.21	—.02	+.09	+.12	.00	+.09
20	— 624.77	—.07	+.05	+.06	—.13	+.02	—.08	—.01	+.02	—.17	+.01	+.08	+.18	+.20	—.10
21	— 141.50			—.27	—.04	.00	+.15						+.09	—.04	+.12
22	— 51.48	+.30	—.18	—.15	—.03	+.21	+.07	—.18	+.01	—.37	+.01	—.03	+.13	+.12	+.11
23	0.00	+.45	+.55	+.64	—.29	—.66	—.30	+.58	+.61	+.62	—.47	—.40	—.34	—.55	—.43
24	+ 0.55	—.09	—.27	+.31	—.05	+.07	—.08					—.07	+.06	+.07	+.01
25	+ 75.75			—.34	+.06	+.14	+.24		—.26			+.06	—.01	—.03	+.18
26	+ 114.02				—.03	+.09	—.05								
27	+ 186.50	.00	+.09	—.10	+.18	—.02	+.14	—.13	—.05	—.20	—.03	+.25	—.07	—.19	+.16
28	+ 257.75	—.12	—.10	+.10	—.09	+.04	+.02	—.24	+.13			+.14	+.30	—.23	+.04
29	+ 483.00		—.13	+.16	+.08		—.18		+.10	+.21	—.13	—.23	+.02	+.07	+.01
30	+ 529.45	—.02	+.30	—.16	+.09	+.01	+.04	.00			+.01	—.03	—.16	—.19	+.08
31	+ 572.61	—.09	—.17	—.12	+.07	.00	—.08	+.09	+.07	—.02	—.07	+.11	+.12	+.06	+.06
32	+ 592.81	+.10	—.24	—.08	+.07	+.02	+.04	—.27	—.09	+.25	+.11	+.07	+.05	.00	—.01
33	+ 651.31	—.13	—.03	—.09	+.02	+.04	+.15	+.12	—.15	—.18	+.05	+.06		+.06	+.10
34	+ 873.46	.00	+.06	—.08	+.05	—.07	+.02	+.16	—.09	—.13	+.10	+.04	—.01	—.16	+.13
35	+ 899.83	—.12	—.03	—.04	+.12	+.07	+.08	+.03	—.03	+.06	—.05	—.13	+.04	—.07	+.04
36	+ 930.72	+.08	+.12	—.06	.00	+.09	—.13	—.12	—.08	+.14	+.10	—.01	—.20	—.07	+.09
37	+ 969.93	—.07	+.13	—.10	+.08	+.09	—.02	—.18			—.14	+.07	—.08	+.12	+.15
38	+1070.18	+.19			—.06	.00	—.14	+.26				—.28	—.04	—.05	+.16
39	+1065.45	+.15	+.24	—.09	—.10	—.11	+.10	—.05				—.05	—.20	—.02	+.08
40	+1334.41				+.06	—.06	—.01								
41	+1549.84	—.18	+.07	—.03	+.05	+.02	—.03	+.11	—.02	—.02	—.02	—.08	.00	+.06	+.02
42	+1790.07	—.14	+.18	—.17	—.02	—.11	+.12	+.30	—.28	—.09		—.11	+.06	+.01	+.28
43	+1839.98	+.16	+.23	—.07	—.14	—.01	+.09					—.31	+.07	—.03	+.02
44	+2251.41			—.28	+.20	+.21								—.14	
45	+2260.58	—.16	+.20	—.08	+.06	+.04	—.01	—.36	—.13	—.11		+.10	+.16	—.01	+.31
46	+2370.39	—.04	—.05	+.09	+.08	+.03	—.01		+.12	—.08	+.15	+.04	—.15	—.02	—.16
47	+2641.78				—.07	+.17						—.10			
48	+2882.41	—.18	—.28	+.08	—.17	+.04	+.15	+.13	—.04	—.10	+.30	+.07	—.10	+.02	+.14

Table V.—ν Cygni Mean Y and Residuals for Each Plate.

Star.	Y_m	1	2	3	4	5	6	7	9	10	11	12	13	14	15
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
1	− 553.47				−.08	+.17	−.04					−.03		+.19	−.22
2	+ 694.84				−.26	−.04	+.12					+.02		+.31	−.15
3	− 385.03	−.06	−.05	+.14	−.08	+.11	+.09	+.18	−.08	−.02	−.12	−.09	+.02	+.25	−.24
4	−1709.13	−.49	−.23	+.09	+.12	+.16	−.01	+.02				+.20	+.09	+.10	−.09
5	−1625.12	−.10	−.22	+.01	.00	+.19	.00	−.22	.00	−.10	+.02	+.07	+.02	+.16	+.10
6	+ 600.16			−.01	−.10	+.09	+.12				−.24	−.02	−.04	+.14	+.02
7	− 921.70	−.05	−.18	−.07	+.11	+.03	+.01	+.20	+.06	−.07	−.06	−.01	+.07	+.05	−.10
8	−1342.61				+.02	−.03	+.02								
9	+ 46.20				−.11	−.06	+.18								
10	−1156.03				+.13	+.05	−.18								
11	−1642.25	+.08	+.06	+.10	−.06	−.09	−.07	+.22	+.11	+.14	+.01	−.14	−.22	−.01	−.10
12	+2318.38	−.12	+.01	−.21	−.01	+.19	+.19		−.03	−.11	+.01	+.13	+.05	+.19	−.23
13	+1494.82	−.29	−.27	−.07	−.08	+.10	+.01		.00	−.05	+.11	+.15	−.08	+.31	+.10
14	+ 649.51	−.20	−.09	−.08	−.04	+.03	−.03	−.02	−.17	−.03	−.21	+.05	+.89	.00	−.07
15	− 971.76	−.08	−.12	−.09	+.04	+.07	+.10		+.03		−.01	+.07	−.05	+.12	−.06
16	−3104.54	+.01	+.05	+.21	−.14	−.17	−.12	+.06	−.01	+.32	+.10	−.03	−.13	−.16	+.07
17	+ 128.28			−.07	−.25	+.01	+.01					+.10		+.21	
18	−2878.11				+.08	−.08	+.01								
19	+1452.90	−.02	−.04	−.12	−.16	+.11	+.23			−.19	−.12	+.04	+.05	+.18	+.10
20	−1825.78	−.11	−.14	−.06	−.06	−.12	+.11	+.05	+.03	−.12	+.14	+.09	+.05	−.04	+.11
21	+1713.93			−.23	−.12	+.09	−.07						+.07	+.22	+.01
22	+ 366.69	−.16	+.04	−.13	−.01	.00	+.06	−.04	−.18	−.01	+.03	+.09	−.08	+.26	+.07
23	0.00	+.36	+.31	+.29	.00	+.05	−.28	+.09	+.34	.00	−.20	−.30	−.32	−.23	−.12
24	−1490.79	−.05	−.15	−.15	−.03	+.07	+.06					+.05	−.08	+.09	+.15
25	+2633.95			−.27	−.10	−.15	+.08		−.10			+.03	+.21	+.28	+.05
26	−1159.54				−.10	+.11	.00								
27	+1875.42	+.11	+.03	−.01	+.06	+.02	+.01	−.18	−.10	+.10	−.05	+.02	−.02	.00	+.02
28	− 699.52	−.22	−.14	−.22	+.12	+.08	+.14	+.01	−.15			+.23	+.15	−.07	+.08
29	−3225.42		−.08	.00	−.11		−.02		−.03	+.01	+.19	+.15	+.03	−.16	+.05
30	+2541.34	−.24	−.28	−.48	+.18	−.06	+.16	−.06			+.04	+.28	−.05	+.29	+.16
31	− 965.53	−.04	−.07	−.17	+.12	+.12	+.04	−.03	+.02	−.15	+.16	+.06	.00	+.04	−.04
32	−1622.60	−.05	−.08	−.02	+.03	−.08	+.12	−.02	+.02	−.10	+.02	+.16	−.02	−.05	+.08
33	− 14.44	+.10	−.24	−.09	−.02	+.15	+.07	−.22	−.14	+.01	+.18	+.08		+.03	+.08
34	+ 674.66	−.07	−.02	−.15	+.07	+.03	+.13	−.11	−.13	−.11	+.09	+.05	−.02	+.07	+.09
35	−1696.29	+.10	−.10	−.09	+.14	+.03	+.05	−.06	−.04	−.02	+.08	−.06	+.01	−.05	+.07
36	+2769.95	+.08	+.16	+.13	−.07	−.08	−.09	−.12	+.09	+.12	+.02	−.04	−.13	+.07	−.16
37	− 658.50	−.15	−.06	−.23	+.01	+.10	−.01	+.01			+.16	+.11	−.10	+.05	+.16
38	−2393.70	−.26			−.21	−.09	+.12	−.20				+.05	+.06	+.22	+.35
39	+1724.46	−.27	+.15	−.35	+.02	.00	+.07	−.09				.00	+.25	+.01	+.16
40	− 72.58				−.12	+.17	−.04								
41	− 759.34	−.09	−.01	−.08	−.02	−.10	+.06	−.08	+.07	+.01	+.11	+.14	−.17	−.08	+.17
42	− 415.60	+.08	+.07	+.03	+.08	−.06	+.15	−.24	−.15	+.04		−.05	−.02	−.10	+.11
43	+ 345.77	+.06	+.08	−.06	.00	+.01	+.07					+.03	−.24	−.03	+.12
44	+1484.31			−.12	−.17	+.16								+.12	
45	+1702.33	−.18	+.03	−.08	−.18	−.01	+.18	−.17	−.06	+.18		+.07	+.09	−.01	+.17
46	−1749.33	−.05	−.06	−.26	+.02	+.10	+.12		−.07	−.02	+.18	−.09	+.03	−.06	+.13
47	+ 864.17				−.08	+.18						−.10			
48	−1993.70	+.19	+.31	−.05	−.06	+.03	−.10	+.08	−.05	+.04	−.14	−.05	+.02	−.28	+.06

Table VI.—ν Cygni Concordance with Astronomische Gesellschaft Catalog.

Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.
1	14767	13	14833	28	14897	38	14921
2	14797	14	14836	29	9789	39	14922
3	14798	15	14841	30	14902	41	14936
4	14801	16	9751	31	14905	42	14944
5	14810	20	9766	32	14906	45	14958
6	14811	22	14884	34	14914	46	14963
7	14813	23	14887	35	14915	48	14976
11	14819	24	14888	36	14918		
12	14832	27	14896	37	14919		

TABLE VII.—ν CYGNI COMPARISON WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

$p = +0.000475 \quad \pm 0.000049$

$r = +0.000147 \quad \pm 0.000049$

$k = +0''.386 \quad \pm 0''.111$

$c = -0''.242 \quad \pm 0''.111$

Probable error of a single equation = ± 0.6356

RESIDUALS.

Star.	v_x	v_y	Star.	v_x	v_y
	″	″		″	″
1	+0.36	+0.03	27	−1.21	−1.18
2	−0.63	+0.76	28	+1.60	−1.46
3	+1.46	−0.43	29	−1.01	−0.78
4	+1.18	+1.23	30	−1.06	−0.41
5	+0.85	+0.25	31	−1.65	+0.11
6	−0.66	+1.45	32	+0.40	−0.28
7	−0.77	+0.80	34	+0.31	−0.20
11	−0.26	−0.29	35	+2.10	+0.72
12	−1.62	−1.27	36	−0.78	+0.76
13	+0.28	+1.54	37	−1.08	−0.65
14	−0.04	+0.78	38	−0.77	+1.34
15	−0.72	+0.74	39	+0.34	−1.08
16	−0.52	−0.25	41	−0.32	−1.05
20	+1.40	+0.44	42	−0.99	−0.68
22	+1.52	−0.18	45	−0.10	+0.88
23	+0.39	−0.24	46	+0.85	−1.02
24	−0.32	−0.42	48	+1.43	+0.08

TABLE VIII. — ν CYGNI FINAL COÖRDINATES.

Star.	*X*	*Y*	Star.	*X*	*Y*
	″	″		″	″
1	−3226.10	− 553.50	25	+ 76.57	+2634.95
2	−2404.16	+ 695.28	26	+ 114.29	−1160.35
3	−2385.23	− 385.10	27	+ 187.26	+1876.04
4	−2364.19	−1709.83	28	+ 258.16	− 700.13
5	−2146.64	−1625.81	29	+ 483.15	−3227.26
6	−2124.85	+ 600.52	30	+ 530.46	+2542.23
7	−2116.42	− 922.07	31	+ 573.13	− 966.31
8	−2041.50	−1343.19	32	+ 593.24	−1623.70
9	−2013.97	+ 46.28	33	+ 652.01	− 14.79
10	−1989.92	−1156.53	34	+ 874.36	+ 674.61
11	−1931.07	−1642.99	35	+ 900.40	−1697.47
12	−1509.05	−2319.46	36	+ 931.96	+2770.89
13	−1511.72	+1495.51	37	+ 970.68	− 659.19
14	−1484.26	+ 649.80	38	+1070.73	−2395.24
15	−1413.11	− 972.25	39	+1066.60	+1724.88
16	−1263.08	−3106.06	40	+1335.42	− 73.05
17	−1139.79	+ 128.27	41	+1550.86	− 760.17
18	−1105.66	−2879.56	42	+1791.25	− 416.30
19	− 794.23	+1453.47	43	+1841.29	+ 345.42
20	− 624.95	−1826.80	44	+2253.09	+1484.45
21	− 140.93	+1714.52	45	+2262.29	+1702.57
22	− 51.06	+ 366.63	46	+2371.65	−1750.75
23	+ 0.39	− 0.24	47	+2643.55	+ 863.95
24	+ 0.72	−1491.74	48	+2883.88	−1995.31

TABLE IX. — ν CYGNI DIAMETERS OF STAR-IMAGES.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r		r
1	0.179	13	0.162	25	0.152	37	0.142
2	0.161	14	0.165	26	0.132	38	0.156
3	0.236	15	0.138	27	0.219	39	0.144
4	0.162	16	0.309	28	0.154	40	0.115
5	0.189	17	0.115	29	0.308	41	0.171
6	0.130	18	0.211	30	0.164	42	0.128
7	0.198	19	0.135	31	0.167	43	0.134
8	0.134	20	0.164	32	0.163	44	0.131
9	0.158	21	0.145	33	0.130	45	0.146
10	0.124	22	0.159	34	0.140	46	0.251
11	0.303	23	0.558	35	0.196	47	0.165
12	0.196	24	0.134	36	0.344	48	0.312

TABLE X. — ν CYGNI FINAL CATALOG.

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Preces-sion.	Secular Varia-tion.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	8.2	6	20 47 47.902	311 56 58.53	+2.2222	+33.3329	+0.0034	+0.0514	40 31 37.03	+13.4058	+0.2353	1876.37
2	8.5	6	20 48 58.875	312 14 43.12	2.2156	33.2346	0.0035	0.0523	40 52 35.25	13.4826	0.2334	76.37
3	7.6	14	20 49 1.489	312 15 22.33	2.2248	33.3722	0.0035	0.0526	40 34 35.19	13.4854	0.2344	76.30
4	8.5	11	20 49 4.473	312 16 7.09	2.2359	33.5389	0.0035	0.0529	40 12 30.86	13.4886	0.2355	76.21
5	8.1	14	20 49 23.395	312 20 50.92	2.2363	33.5440	0.0035	0.0532	40 13 56.88	13.5090	0.2352	76.30
6	9.0	9	20 49 23.571	312 20 53.57	+2.2178	+33.2672	+0.0035	+0.0528	40 51 3.16	+13.5092	+0.2332	76.39
7	8.0	14	20 49 25.493	312 21 22.39	2.2306	33.4587	0.0035	0.0531	40 25 40.79	13.5113	0.2346	76.30
8	8.9	3	20 49 32.366	312 23 5.49	2.2344	33.5165	0.0036	0.0533	40 18 40.36	13.5187	0.2349	75.86
9	8.5	3	20 49 33.752	312 23 26.28	2.2230	33.3450	0.0035	0.0530	40 41 49.92	13.5202	0.2336	75.86
10	9.1	3	20 49 36.739	312 24 11.09	2.2331	33.4971	0.0036	0.0534	40 21 47.42	13.5234	0.2347	75.86
11	7.1	14	20 49 42.228	312 25 33.42	+2.2374	+33.5615	+0.0036	+0.0535	40 13 41.50	+13.5293	+0.2350	76.30
12	8.0	13	20 50 16.877	312 34 13.16	2.2063	33.0952	0.0035	0.0532	41 19 46.61	13.5666	0.2311	76.29
13	8.5	13	20 50 17.104	312 34 16.56	2.2133	33.1997	0.0036	0.0535	41 6 2.75	13.5668	0.2319	76.29
14	8.4	14	20 50 19.997	312 34 59.96	2.2206	33.3085	0.0036	0.0537	40 51 57.28	13.5699	0.2326	76.30
15	8.8	12	20 50 27.107	312 36 46.61	2.2344	33.5160	0.0036	0.0542	40 24 55.74	13.5776	0.2340	76.27
16	7.0	14	20 50 41.215	312 40 18.22	+2.2526	+33.7886	+0.0036	+0.0547	39 49 23.05	+13.5927	+0.2357	76.30
17	9.2	6	20 50 50.581	312 42 38.71	2.2266	33.3993	0.0036	0.0544	40 43 17.66	13.6028	0.2328	76.15
18	7.9	3	20 50 54.787	312 43 41.81	2.2515	33.7723	0.0037	0.0549	39 53 10.25	13.6073	0.2353	75.86
19	8.9	12	20 51 20.588	312 50 8.82	2.2173	33.2594	0.0036	0.0546	41 5 24.21	13.6349	0.2313	76.27
20	8.4	14	20 51 36.311	312 54 4.67	2.2452	33.6785	0.0037	0.0555	40 10 44.55	13.6517	0.2340	76.30
21	8.7	7	20 52 18.361	313 4 35.41	+2.2184	+33.2765	+0.0037	+0.0556	41 9 46.54	+13.6965	+0.2304	76.26
22	8.5	14	20 52 26.344	313 6 35.16	2.2301	33.4513	0.0037	0.0560	40 47 18.72	13.7050	0.2315	76.30
23	5.7	14	20 52 30.874	313 7 43.11	2.2334	33.5006	0.0037	0.0562	40 41 11.86	13.7099	0.2318	76.30
24	8.9	10	20 52 30.903	313 7 43.54	2.2456	33.6836	0.0038	0.0564	40 16 20.39	13.7099	0.2331	76.18
25	8.6	9	20 52 37.647	313 9 24.70	2.2119	33.1778	0.0037	0.0557	41 25 6.90	13.7171	0.2294	76.36

TABLE X. —ν CYGNI FINAL CATALOG. — *Concluded.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
26	8.9	3	20 52 40.840	313 10 12.60	+2.2434	+33.6515	+0.0038	+0.0565	40 21 51.74	+13.7205	+0.2327	1875.86
27	7.8	14	20 52 47.433	313 11 51.50	2.2188	33.2817	0.0037	0.0561	41 12 28.01	13.7275	0.2300	76.30
28	8.6	12	20 52 53.471	313 13 22.06	2.2404	33.6059	0.0038	0.0567	40 29 31.84	13.7339	0.2322	76.24
29	7.0	11	20 53 12.753	313 18 11.30	2.2619	33.9284	0.0038	0.0573	39 47 24.63	13.7543	0.2341	76.39
30	8.4	12	20 53 17.976	313 19 29.64	2.2150	33.2250	0.0038	0.0564	41 23 33.60	13.7599	0.2291	76.26
31	8.4	14	20 53 21.026	313 20 15.39	+2.2441	+33.6621	+0.0038	+0.0572	40 25 5.12	+13.7631	+0.2321	76.30
32	8.5	14	20 53 22.645	313 20 39.68	2.2496	33.7434	0.0038	0.0573	40 14 7.71	13.7649	0.2327	76.30
33	9.0	13	20 53 28.159	313 22 2.39	2.2368	33.5517	0.0038	0.0572	40 40 56.42	13.7707	0.2312	76.26
34	8.8	14	20 53 47.927	313 26 58.91	2.2323	33.4840	0.0038	0.0574	40 52 25.10	13.7916	0.2304	76.30
35	8.0	14	20 53 49.444	313 27 21.66	2.2517	33.7752	0.0039	0.0578	40 12 53.01	13.7933	0.2324	76.30
36	6.8	14	20 53 53.732	313 28 25.98	+2.2152	+33.2281	+0.0038	+0.0571	41 27 20.96	+13.7978	+0.2285	76.30
37	8.8	12	20 53 55.945	313 28 59.17	2.2436	33.6546	0.0039	0.0578	40 30 10.96	13.8001	0.2315	76.26
38	8.6	9	20 54 4.044	313 31 0.66	2.2581	33.8718	0.0039	0.0581	40 1 14.64	13.8087	0.2329	76.35
39	8.7	11	20 54 5.291	313 31 19.36	2.2246	33.3690	0.0038	0.0575	41 9 54.53	13.8100	0.2293	75.21
40	9.2	3	20 54 28.208	313 37 3.12	2.2407	33.6111	0.0039	0.0583	40 39 55.34	13.8342	0.2306	75.86
41	8.3	14	20 54 46.753	313 41 41.29	+2.2474	+33.7109	+0.0039	+0.0587	40 28 26.96	+13.8538	+0.2310	76.30
42	9.0	13	20 55 8.043	313 47 0.64	2.2458	33.6877	0.0039	0.0590	40 34 9.14	13.8762	0.2305	76.26
43	8.9	10	20 55 12.948	313 48 14.22	2.2399	33.5991	0.0039	0.0590	40 46 50.43	13.8814	0.2298	76.18
44	8.9	4	20 55 50.146	313 57 32.19	2.2328	33.4922	0.0040	0.0595	41 5 45.79	13.9205	0.2284	76.05
45	8.7	13	20 55 51.142	313 57 47.13	2.2311	33.4662	0.0040	0.0595	41 9 23.79	13.9215	0.2282	76.26
46	7.5	13	20 55 57.823	313 59 27.35	+2.2595	+33.8922	+0.0040	+0.0601	40 11 49.87	+13.9285	+0.2311	76.29
47	8.4	3	20 56 24.072	314 6 1.08	2.2399	33.5988	0.0040	0.0603	40 55 21.36	13.9561	0.2286	76.20
48	7.0	14	20 56 42.265	314 10 33.97	2.2640	33.9601	0.0041	0.0610	40 07 39.86	13.9751	0.2308	76.30

TABLE I.—PHOTOGRAPHS OF 71 CYGNI.

OBSERVATORY OF L. M. RUTHERFURD, NEW YORK.

Lat. 40° 43′ 48″.5. Long. $4^h\ 55^m\ 56^s.62$ W.

Plate No.	Date.	Sidereal Time.	Barometer.	Thermometer.			Focus.	Zen. Dist.
				Att.	Ex.	Tel.		
		h m s	in.					°
1	1875 Aug. 5	19 44 52	30.050	72°	69°	74°	7.6	18.6
2	1875 Aug. 5	20 15 52	30.050	72	69	74	7.6	13.6
3	1875 Aug. 5	20 48 52	30.050	72	69	74	7.6	8.4
4	1875 Nov. 24	0 33 18	30.432	39	36	38	7.85	34.1
5	1875 Nov. 25	23 20 2	30.562	37	35	38	7.85	21.5
6	1875 Nov. 27	23 40 32	30.386	42	43	42	7.85	25.0
8	1876 July 27	19 9 2	30.210	72	70	75	7.75	25.0
9	1876 Aug. 5	19 5 2	30.260	77	75	78	7.52	25.7
11	1876 Nov. 24	1 11 48	29.960	39	36	40	7.9	40.7
12	1876 Nov. 28	0 13 12	29.922	37	36	38	7.9	30.7

TABLE II.—71 CYGNI CORRECTED COÖRDINATES.

PLATE 1.		
Star.	*X*	*Y*
1	−53.6881	−2.2366
2	−48.3000	+12.7851
3	−48.7943	−31.8326
4	−45.2680	+33.9347
5	−43.3877	−12.7390
6	−42.7852	+20.2446
7	−41.4971	−10.5310
8	−39.8966	+22.4807
9	−39.4138	+15.4004
10	−34.3341	+12.3146
11	−33.4586	+27.4668
12	−30.4084	+5.7320
13	−29.8749	+6.8402
14	−27.4511	−8.8852
15	−27.0659	+24.5883
16	−24.2118	+31.6384
17	−22.7026	−7.8997
18	−22.4814	+13.6943
19	−22.3895	+19.6874
20	−22.4006	−38.5586
21	−20.3928	−40.1640
22	−18.6558	+36.1576
23	−17.9364	+1.9047
24	−16.4857	−8.3886
25	−14.7637	−19.4560
26	−11.9378	+9.5558
27	−11.5858	+19.8881
28	−11.5535	+17.3496
29	−11.3187	+26.4726
30	−10.8799	+9.4307
31	−10.5490	−23.2630
33	−9.6016	+37.7256
34	−8.4724	+37.2897
35	−6.8076	+39.4132
36	−6.5327	+39.0724
37	−6.0209	−0.6694
39	−4.4294	+26.6506
40	−3.1630	−3.3151
41	−2.2380	+50.2689
42	−0.9908	+40.1028
43	−0.8002	−4.3439
44	0.0000	0.0000
45	+0.3406	+24.3934
46	+0.6637	+7.0570
47	+1.0560	+42.8710
48	+1.9109	−7.5483
49	+2.0712	−27.6098
50	+2.0426	+27.6303
51	+2.5475	−44.5776
52	+3.3907	−17.3642
54	+4.4956	+13.0449
55	+4.6226	−13.6754
56	+6.3910	−4.9826
57	+7.0538	+56.5122
58	+7.1675	+34.3050
59	+10.4410	+43.1170
60	+12.3756	−0.2157
61	+12.5284	−14.1598
62	+13.0827	−29.7020
63	+15.3853	−17.8996
65	+21.7446	+4.0004
66	+23.5538	−22.6576
67	+23.7564	+49.1745
68	+27.4198	+19.5053
69	+31.5917	+33.1328
70	+32.6708	−41.7939
71	+32.7765	−19.2399
72	+44.0816	+37.7762
73	+54.0390	+22.9027
74	+54.5142	+26.6949
77	+58.2534	−4.9588

PLATE 2.		
Star.	*X*	*Y*
1	−53.6914	−2.2084
2	−48.2978	+12.8134
3	−48.8113	−31.8048
4	−45.2514	+33.9597
5	−43.3952	−12.7172
6	42.7781	+20.2684
7	−41.5052	−10.5055
8	−39.8791	+22.4964
9	−39.4056	+15.4210
10	−34.3270	+12.3332
11	−33.4447	+27.4866
12	−30.4042	+5.7498
13	−29.8666	+6.8598
14	−27.4550	−8.8695
15	−27.0522	+24.6057
16	−24.1893	+31.6510
17	−22.7083	−7.8867
18	−22.4731	+13.7098
19	−22.3772	+19.7005
20	−22.4240	−38.5414
21	−20.4276	−40.1504
22	−18.6378	+36.1666
23	−17.9383	+1.9194
24	−16.4926	−8.3779
25	−14.7678	−19.4478
26	−11.9369	+9.5665
27	−11.5796	+19.8978
28	−11.5549	+17.3563
29	−11.3100	+26.4784
30	−10.8776	+9.4393
31	−10.5610	−23.2506
32	−10.1183	+38.3750
33	−9.5863	+37.7355
34	−8.4614	+37.2926
35	−6.7902	+39.4247
36	−6.4997	+39.0749
37	−6.0270	−0.6654
38	−5.3374	+18.3129
39	−4.4167	+26.6531
40	−3.1676	−3.3092
41	−2.2070	+50.2594
42	−0.9710	+40.1078
43	−0.8011	−4.3385
44	0.0000	0.0000
45	+0.3466	+24.3966
46	+0.6686	+7.0619
47	+1.0780	+42.8718
48	+1.9065	−7.5478
49	+2.0560	−27.6034
50	+2.0615	+27.6307
51	+2.5233	−44.5717
52	+3.3862	−17.3619
53	+4.2531	+46.3584
54	+4.4899	+13.0409
55	+4.6129	−13.6726
56	+6.3784	−4.9826
57	+7.0828	+56.5036
58	+7.1756	+34.3010
59	+10.4627	+43.1178
60	+12.3747	−0.2166
61	+12.5217	−14.1646
62	+13.0626	−29.6988
63	+15.3745	−17.9052
64	+19.8249	+56.2958
65	+21.7531	+3.9971
66	+23.5411	−22.6657
67	+23.7816	+49.1665
68	+27.4247	+19.4975
69	+31.6030	+33.1205
70	+32.6404	−41.8057
71	+32.7640	−19.2505
72	+44.0869	+37.7642
73	+54.0480	+22.8849
74	+54.5266	+26.6692
75	+56.6410	−13.4690
76	+57.4654	−37.0410
77	+58.2506	−4.9842

TABLE II.—71 CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 3.

Star.	*X*	*Y*
1	—53.6855	— 2.1949
2	—48.2936	+12.8302
3	—48.8234	—31.7894
4	—45.2408	+33.9782
5	—43.3849	—12.7018
6	—42.7704	+20.2826
7	—41.5045	—10.4972
8	—39.8669	+22.5041
9	—39.3963	+15.4311
10	—34.3194	+12.3461
11	—33.4283	+27.4942
12	—30.4053	+ 5.7585
13	—29.8545	+ 6.8670
14	—27.4581	— 8.8639
15	—27.0374	+24.6093
16	—24.1853	+31.6578
17	—22.7081	— 7.8800
18	—22.4656	+13.7154
19	—22.3724	+19.7015
20	—22.4288	—38.5361
21	—20.4302	—40.1436
23	—17.9327	+ 1.9218
24	—16.4901	— 8.3762
25	—14.7698	—19.4475
26	—11.9334	+ 9.5666
27	—11.5602	+19.8996
29	—11.2999	+26.4790
30	—10.8733	+ 9.4395
31	—10.5676	—23.2543
32	—10.1099	+38.3597
33	— 9.5686	+37.7331
35	— 6.7656	+39.4189
37	— 6.0257	— 0.6668
38	— 5.3269	+18.3194
39	— 4.4032	+26.6539
40	— 3.1638	— 3.3115
41	— 2.1914	+50.2691
42	— 0.9477	+40.1050
43	— 0.7997	— 4.3427
44	0.0000	0.0000
45	+ 0.3611	+24.3911
46	+ 0.6721	+ 7.0516
47	+ 1.0968	+42.8652
48	+ 1.9061	— 7.5514
49	+ 2.0476	—27.6088
50	+ 2.0754	+27.6314
51	+ 2.5096	—44.5789
53	+ 4.2838	+46.3386
54	+ 4.5026	+13.0398
55	+ 4.6205	—13.6806
56	+ 6.3811	— 4.9944
57	+ 7.1067	+56.5048
58	+ 7.2128	+34.2966
59	+10.4842	+43.1080
60	+12.3804	— 0.2240
61	+12.5243	—14.1734
62	+13.0551	—29.7072
63	+15.3713	—17.9249
64	+19.8585	+56.2822
65	+21.7508	+ 3.9841
66	+23.5399	—22.6793
67	+23.8033	+49.1548
68	+27.4349	+19.4802
69	+31.6265	+33.1067
70	+32.6299	—41.8288
71	+32.7550	—19.2658
72	+44.1118	+37.7369
73	+54.0644	+22.8518
74	+54.5472	+26.6414
75	+56.6394	—13.4964
76	+57.4549	—37.0661
77	+58.2552	— 5.0118

PLATE 4.

Star.	*X*	*Y*
1	—53.6785	— 2.2473
2	—48.3010	+12.7789
3	—48.7766	—31.8329
6	—42.7787	+20.2436
7	—41.4762	—10.5306
8	—39.8809	+22.4718
9	—39.4121	+15.3974
10	—34.3297	+12.3129
11	—33.4543	+27.4666
13	—29.8569	+ 6.8438
14	—27.4416	— 8.8850
15	—27.0620	+24.5886
17	—22.6929	— 7.8982
18	—22.4810	+13.7016
19	—22.3866	+19.6893
20	—22.3846	—38.5514
21	—20.3828	—40.1597
23	—17.9323	+ 1.9060
24	—16.4729	— 8.3861
25	—14.7494	—19.4530
26	—11.9366	+ 9.5641
28	—11.5492	+17.3580
29	—11.3224	+26.4778
30	—10.8734	+ 9.4370
31	—10.5373	—23.2517
32	—10.1409	+38.3646
33	— 9.6084	+37.7346
34	— 8.4736	+37.2925
35	— 6.8155	+39.4263
37	— 6.0156	— 0.6594
39	— 4.4275	+26.6589
40	— 3.1530	— 3.3020
41	— 2.2436	+50.2704
42	— 0.9940	+40.1110
43	— 0.7898	— 4.3329
44	0.0000	0.0000
45	+ 0.3367	+24.4015
46	+ 0.6650	+ 7.0630
47	+ 1.0523	+42.8776
48	+ 1.9141	— 7.5445
49	+ 2.0854	—27.5990
50	+ 2.0467	+27.6355
51	+ 2.5664	—44.5663
52	+ 3.4009	—17.3533
53	+ 4.2224	+46.3562
54	+ 4.4936	+13.0492
55	+ 4.6346	—13.6638
56	+ 6.3928	— 4.9700
57	+ 7.0446	+56.5184
59	+10.4322	+43.1289
60	+12.3816	— 0.2047
61	+12.5365	—14.1498
62	+13.0854	—29.6880
63	+15.3929	—17.8872
64	+19.7991	+56.3190
65	+21.7524	+ 4.0166
66	+23.5695	—22.6494
67	+23.7466	+49.1883
68	+27.4129	+19.5216
69	+31.5845	+33.1489
71	+32.7790	—19.2259

PLATE 5.

Star.	*X*	*Y*
1	—53.6890	— 2.2266
2	—48.3017	+12.7992
3	—48.7978	—31.8156
6	—42.7768	+20.2577
7	—41.4908	—10.5182
8	—39.8837	+22.4884
9	—39.4062	+15.4093
10	—34.3266	+12.3255
11	—33.4453	+27.4788
12	—30.4037	+ 5.7415
13	—29.8620	+ 6.8538
14	—27.4491	— 8.8789
15	—27.0550	+24.5954
16	—24.2004	+31.6411

TABLE II.—71 CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 5.

Star.	X	Y
17	—22.7005	— 7.8927
18	—22.4720	+13.7035
19	—22.3851	+19.6940
20	—22.4071	—38.5459
22	—18.6298	+36.1675
23	—17.9348	+ 1.9109
24	—16.4835	— 8.3831
25	—14.7608	—19.4543
26	—11.9340	+ 9.5630
27	—11.5711	+19.8960
28	—11.5404	+17.3534
29	—11.3115	+26.4772
30	—10.8711	+ 9.4377
31	—10.5493	—23.2572
32	—10.1290	+38.3580
33	— 9.5933	+37.7332
34	— 8.4561	+37.2897
35	— 6.7982	+39.4188
36	— 6.5092	+39.0704
37	— 6.0146	— 0.6645
38	— 5.3387	+18.3134
39	— 4.4155	+26.6538
40	— 3.1602	— 3.3112
41	— 2.2247	+50.2727
42	— 0.9754	+40.1066
43	— 0.7952	— 4.3409
44	0.0000	0.0000
45	+ 0.3477	+24.3949
47	+ 1.0714	+42.8742
48	+ 1.9116	— 7.5477
49	+ 2.0694	—27.6057
50	+ 2.0610	+27.6290
51	+ 2.5468	—44.5769
52	+ 3.4010	—17.3627
53	+ 4.2458	+46.3570
54	+ 4.4999	+13.0470
55	+ 4.6286	—13.6757
57	+ 7.0673	+56.5112
59	+10.4531	+43.1221
60	+12.3830	— 0.2138
61	+12.5335	—14.1610
63	+15.3862	—17.9009
64	+19.8159	+56.3069
65	+21.7559	+ 3.9999
66	+23.5568	—22.6646
67	+23.7695	+49.1727
68	+27.4276	+19.5030
69	+31.6033	+33.1281
71	+32.7691	—19.2448
72	+44.1004	+37.7615

PLATE 6.

Star.	X	Y
1	—53.6904	— 2.2136
2	—48.2989	+12.8119
3	—48.8024	—31.8054
5	—43.3870	—12.7174
6	—42.7749	+20.2699
7	—41.4946	—10.5087
8	—39.8745	+22.4924
9	—39.4009	+15.4169
10	—34.3245	+12.3332
11	—33.4418	+27.4874
12	—30.4040	+ 5.7481
13	—29.8634	+ 6.8588
14	—27.4476	— 8.8656
15	—27.0519	+24.6027
16	—24.1952	+31.6448
17	—22.7044	— 7.8858
18	—22.4706	+13.7113
19	—22.3799	+19.6994
20	—22.4148	—38.5395
21	—20.4124	—40.1505
23	—17.9343	+ 1.9156
24	—16.4872	— 8.3788
25	—14.7628	—19.4479
26	—11.9316	+ 9.5673
27	—11.5703	+19.9004
28	—11.5437	+17.3614
29	—11.3070	+26.4829
30	—10.8716	+ 9.4400
31	—10.5605	—23.2527
32	—10.1252	+38.3660
33	— 9.5891	+37.7412
34	— 8.4441	+37.2906
35	— 6.7882	+39.4288
36	— 6.5110	+39.0836
37	— 6.0226	— 0.6625
38	— 5.3378	+18.3178
39	— 4.4146	+26.6579
40	— 3.1608	— 3.3059
42	— 0.9658	+40.1106
43	— 0.7968	— 4.3372
44	0.0000	0.0000
45	+ 0.3506	+24.3976
46	+ 0.6725	+ 7.0634
47	+ 1.0811	+42.8790
48	+ 1.9090	— 7.5460
49	+ 2.0614	—27.6060
50	+ 2.0620	+27.6368
51	+ 2.5309	—44.5714
52	+ 3.3941	—17.3644
53	+ 4.2578	+46.3580
54	+ 4.4972	+13.0440
55	+ 4.6185	—13.6702
56	+ 6.3877	— 4.9774
58	+ 7.1846	+34.3123
59	+10.4650	+43.1208
60	+12.3802	— 0.2160
61	+12.5280	—14.1624
62	+13.0736	—29.6988
63	+15.3827	—17.9030
65	+21.7530	+ 4.0024
66	+23.5490	—22.6662
67	+23.7781	+49.1732
68	+27.4264	+19.5010
69	+31.6074	+33.1264
71	+32.7676	—19.2511
72	+44.1106	+37.7670
73	+54.0650	+22.8806
74	+54.5360	+26.6768
76	+57.4808	—37.0450

PLATE 8.

Star.	X	Y
1	—53.6854	— 2.1871
2	—48.2813	+12.8353
6	—42.7614	+20.2907
7	—41.5072	—10.4870
8	—39.8655	+22.5121
9	—39.3914	+15.4342
10	—34.3171	+12.3472
11	—33.4242	+27.4986
12	—30.3982	+ 5.7604
13	—29.8548	+ 6.8720
14	—27.4601	— 8.8578
15	—27.0323	+24.6103
17	—22.7094	— 7.8757
18	—22.4646	+13.7163
19	—22.3624	+19.7020
20	—22.4428	—38.5283
21	—20.4428	—40.1412
22	—18.6070	+36.1737
23	—17.9338	+ 1.9248
24	—16.4932	— 8.3732
25	—14.7829	—19.4425
26	—11.9282	+ 9.5700
29	—11.2878	+26.4796
30	—10.8648	+ 9.4406
31	—10.5780	—23.2486
32	—10.1048	+38.3634
33	— 9.5606	+37.7316
34	— 8.4286	+37.2859
35	— 6.7646	+39.4227
37	— 6.0248	— 0.6642

TABLE II.—71 CYGNI CORRECTED COÖRDINATES.—*Continued.*

PLATE 8.

Star.	X	Y
38	— 5.3280	+18.3155
39	— 4.4014	+26.6473
41	— 2.1796	+50.2612
42	— 0.9441	+40.1019
43	— 0.8040	— 4.3412
44	0.0000	0.0000
45	+ 0.3634	+24.3921
47	+ 1.1013	+42.8625
48	+ 1.9030	— 7.5486
49	+ 2.0404	—27.6074
50	+ 2.0784	+27.6258
51	+ 2.5064	—44.5704
53	+ 4.2816	+46.3356
54	+ 4.5039	+13.0336
55	+ 4.6019	—13.6797
56	+ 6.3763	— 4.9898
57	+ 7.1111	+56.4939
58	+ 7.2061	+34.2986
59	+10.4858	+43.1033
60	+12.3754	— 0.2260
61	+12.5144	—14.1716
62	+13.0424	—29.7060
63	+15.3625	—17.9130
65	+21.7506	+ 3.9824
66	+23.5345	—22.6821
67	+23.8082	+49.1456
68	+27.4318	+19.4767
69	+31.6208	+33.0990
71	+32.7465	— 19.2714
72	+44.1126	+37.7256
73	+54.0588	+22.8450
74	+54.5361	+26.6336
75	+56.6344	—13.5032
76	+57.4429	—37.0739
77	+58.2452	— 5.0130

PLATE 9.

Star.	X.	Y.
1	—53.6811	— 2.2374
2	—48.2904	+12.7888
3	—48.7892	—31.8248
5	—43.3790	—12.7357
6	—42.7782	+20.2440
7	—41.4939	—10.5263
8	—39.8822	+22.4718
9	—39.4053	+15.3970
10	—34.3252	+12.3141
11	—33.4470	+27.4646
12	—30.4056	+ 5.7330
13	—29.8659	+ 6.8389
15	—27.0567	+24.5895
16	—24.2019	+31.6250
17	—22.7011	— 7.8981
18	—22.4784	+13.6927
19	—22.3842	+19.6827
20	—22.4012	—38.5497
23	—17.9362	+ 1.9070
24	— 16.4850	— 8.3860
25	—14.7566	—19.4564
26	—11.9378	+ 9.5574
29	—11.3202	+26.4662
30	—10.8787	+ 9.4296
31	—10.5513	—23.2563
33	— 9.6012	+37.7222
34	— 8.4704	+37.2838
35	— 6.8072	+39.4081
37	— 6.0256	— 0.6698
39	— 4.4286	+26.6464
42	— 0.9882	+40.0961
43	— 0.7985	— 4.3438
44	0.0000	0.0000
45	+ 0.3360	+24.3891
47	+ 1.0574	+42.8625
48	+ 1.9088	— 7.5490
49	+ 2.0685	—27.6062
50	+ 2.0506	+27.6254
51	+ 2.5510	—44.5655
53	+ 4.2324	+46.3431
54	+ 4.4856	+13.0379
55	+ 4.6194	—13.6742
57	+ 7.0559	+56.4947
59	+10.4428	+43.1112
60	+12.3746	— 0.2167
61	+12.5246	—14.1614
62	+13.0711	—29.6987
65	+21.7423	+ 4.0062
67	+23.7587	+49.1649
68	+27.4110	+19.5005
69	+31.5877	+33.1262
71	+32.7671	— 19.2384
72	+44.0720	+37.7690
74	+54.5182	+26.6829

PLATE 11.

Star.	X	Y
1	—53.6728	— 2.2709
2	—48.3019	+12.7579
3	—48.7594	—31.8608
4	—45.2741	+33.9080
5	—43.3574	—12.7615
6	—42.7916	+20.2271
7	—41.4749	—10.5547
8	—39.8918	+22.4576
9	—39.4156	+15.3766
10	—34.3324	+12.2982
11	—33.4680	+27.4465
12	—30.3969	+ 5.7196
13	—29.8667	+ 6.8210
14	—27.4269	— 8.9021
15	—27.0715	+24.5775
17	—22.6885	— 7.9106
18	—22.4814	+13.6859
19	—22.4007	+19.6755
20	—22.3561	—38.5675
23	—17.9319	+ 1.8983
24	—16.4702	— 8.3964
25	—14.7365	—19.4632
26	—11.9417	+ 9.5512
29	—11.3314	+26.4661
30	—10.8767	+ 9.4274
31	—10.5310	—23.2592
33	— 9.6304	+37.7319
34	— 8.4898	+37.2899
37	— 6.0130	— 0.6666
38	— 5.3565	+18.3122
39	— 4.4522	+26.6537
41	— 2.2756	+50.2661
42	— 1.0131	+40.1090
43	— 0.7914	— 4.3392
44	0.0000	0.0000
45	+ 0.3248	+24.3980
47	+ 1.0296	+42.8706
48	+ 1.9187	— 7.5456
49	+ 2.0974	—27.6023
51	+ 2.5919	—44.5626
53	+ 4.1999	+46.3674
54	+ 4.4870	+13.0529
55	+ 4.6384	—13.6693
57	+ 7.0169	+56.5197
59	+10.4120	+43.1285
60	+12.3796	— 0.1991
61	+12.5410	—14.1476
62	+13.0946	—29.6920
65	+21.7499	+ 4.0242
66	+23.5802	—22.6409
67	+23.7233	+ 40.1954
68	+27.4013	+19.5297
69	+31.5546	+33.1580
71	+32.7854	—19.2174

TABLE II.—71 CYGNI CORRECTED COÖRDINATES.—*Concluded.*

PLATE 12.

Star.	*X*	*Y*	Star.	*X*	*Y*	Star.	*X*	*Y*
1	—53.6808	— 2.2452	24	—16.4788	— 8.3901	48	+ 1.9150	— 7.5472
2	—48.2990	+12.7832	25	—14.7559	—19.4588	49	+ 2.0798	—27.6065
3	—48.7850	—31.8361	26	—11.9378	+ 9.5590	50	+ 2.0507	+27.6296
4	—45.2581	+33.9322	28	—11.5570	+17.3532	51	+ 2.5674	—44.5697
5	—43.3747	—12.7387	29	—11.3194	+26.4732	53	+ 4.2284	+46.3482
6	—42.7845	+20.2438	30	—10.8749	+ 9.4312	54	+ 4.4932	+13.0462
7	—41.4899	—10.5305	31	—10.5465	—23.2588	55	+ 4.6298	—13.6730
8	—39.8856	+22.4697	32	—10.1561	+38.3636	56	+ 6.3889	— 4.9823
9	—39.4094	+15.3948	33	— 9.6118	+37.7306	57	+ 7.0512	+56.5163
10	—34.3296	+12.3148	34	— 8.4702	+37.2905	59	+10.4377	+43.1220
11	—33.4548	+27.4690	35	— 6.8076	+39.4198	60	+12.3784	— 0.2118
12	—30.4031	+ 5.7320	36	— 6.5286	+39.0619	61	+12.5348	—14.1579
13	—29.8619	+ 6.8409	37	— 6.0222	— 0.6664	62	+13.0803	—29.6947
14	—27.4424	— 8.8885	38	— 5.3433	+18.3094	63	+15.3926	—17.8998
15	—27.0613	+24.5902	39	— 4.4252	+26.6478	65	+21.7533	+ 4.0100
16	—24.2197	+31.6404	40	— 3.1561	— 3.3184	66	+23.5636	—22.6574
17	—22.6970	— 7.9004	42	— 0.9909	+40.1047	67	+23.7520	+49.1802
18	—22.4785	+13.6975	43	— 0.7949	— 4.3405	68	+27.4173	+19.5114
19	—22.3908	+19.6874	44	0.0000	0.0000	69	+31.5873	+33.1372
20	—22.3927	—38.5535	45	+ 0.3380	+24.3956	71	+32.7756	—19.2380
21	—20.3882	—40.1636	46	+ 0.6708	+ 7.0584	76	+57.5011	—37.0232
23	—17.9324	+ 1.9036	47	+ 1.0573	+42.8744			

TABLE III.—71 CYGNI REFRACTION COEFFICIENTS.

Plate.	M_x	N_x	M_y	N_y
1	+0.000308	+0.000101	—0.000093	+0.000277
2	+ .000291	+ .000071	— .000062	+ .000278
3	+ .000280	+ .000037	— .000031	+ .000279
4	+ .000434	— .000188	+ .000228	+ .000302
5	+ .000348	— .000125	+ .000119	+ .000301
6	+ .000359	— .000142	+ .000143	+ .000295
8	+ .000338	+ .000134	— .000134	+ .000277
9	+ .000339	+ .000136	— .000138	+ .000275
11	+ .000500	— .000205	+ .000305	+ .000307
12	+ .000397	— .000170	+ .000190	+ .000295

TABLE IV.—71 CYGNI PLATE CONSTANTS.

Plate.	*p*	*r*	Probable Error of *p* or *r*.	*k*	*c*	Probable Error of *k* or *c*.	Probable Error of One Equation.
1	—0.000027	+0.000048	±0.000008	+0″.113	+0″.145	±0″.014	±0″.0860
2	+ .000009	— .000405	.000006	+ .179	— .052	.010	.0628
3	+ .000005	— .000742	.000008	— .038	+ .164	.015	.0884
4	— .000026	+ .000621	.000008	— .183	— .296	.013	.0799
5	— .000069	+ .000063	.000006	— .124	— .010	.011	.0665
6	— .000062	— .000121	.000006	— .030	— .122	.010	.0608
8	+ .000093	— .001027	.000007	+ .129	+ .154	.013	.0793
9	+ .000144	— .000036	.000006	+ .158	+ .149	.011	.0674
11	— .000027	+ .001137	.000009	— .130	— .137	.017	.0998
12	— .000039	+ .000460	.000006	— .072	+ .003	.011	.0658

TABLE V.—71 CYGNI MEAN X AND RESIDUALS FOR EACH PLATE.

Star.	X_m	1	2	3	4	5	6	8	9	11	12
	″	″	″	″	″	″	″	″	″	″	″
1	—2839.30	+.11	.00	+.20	—.08	—.16	—.15	—.04	—.05	+.03	+.08
2	—2554.38	+.25	+.07	—.14	—.22	—.20	—.16	+.18	+.26	—.05	+.03
3	—2580.72	+.11	+.04	—.17	—.06	+.04	+.18		—.03	—.11	—.02
4	—2393.50	—.11	—.08	—.37						+.27	+.29
5	—2294.35	—.19	—.24	+.37			—.05		—.12	+.20	+.04
6	—2262.52	+.10	—.01	—.18	+.17	+.09	+.03	—.08	+.02	—.07	—.07
7	—2194.53	—.02	—.14	—.07	+.36	+.21	+.17	—.27	—.21	+.05	—.06
8	—2109.29	—.34	+.03	+.05	+.26	—.14	+.16	—.24	—.02	+.20	+.06
9	—2084.16	.00	+.07	+.08	—.24	—.01	+.16	+.05	+.03	—.10	.00
10	—1815.52	—.02	+.07	+.03	—.13	.00	+.04	—.06	+.09	—.01	—.02
11	—1769.01	—.11	—.04	+.10	.00	+.05	.00	—.06	+.12	—.05	—.04
12	—1607.99	+.01	+.12	—.25		—.04	—.06	+.01	—.14	+.30	+.02
13	—1579.42	—.35	—.04	+.27	+.21	+.03	—.06	+.13	—.16	—.17	+.08
14	—1451.67	—.04	+.02	—.16	—.14	—.05	+.18	—.23		+.35	+.06
15	—1430.94	—.13	.00	+.11	—.03	—.06	—.08	+.09	+.06	+.07	.00
16	—1280.07	—.01	+.42	—.19		+.01	+.02		+.23		—.47
17	—1200.64	+.06	+.01	—.03	+.02	+.02	—.02	—.03	—.04	+.01	+.02
18	—1188.69	—.02	+.12	+.05	—.24	+.10	+.10	—.03	—.08	+.08	—.03
19	—1183.84	+.06	+.24	—.10	+.04	—.18	—.04	+.23	+.08	—.21	—.16
20	—1184.92	+.08	—.12	+.17	—.10	—.07	.00	—.18	—.05	+.36	—.06
21	—1079.08	+.40	—.36	+.09	—.10		+.09	—.17			+.08
22	— 985.90	—.32	—.24			+.43		+.15			
23	— 948.53	+.09	—.01	+.04	—.08	—.07	+.01	.00	—.05	—.01	+.05
24	— 871.80	—.00	—.09	.00	+.15	—.01	—.05	—.05	—.07	+.06	+.06
25	— 780.64	—.18	+.16	+.22	—.11	—.04	+.14	—.22	+.14	+.06	—.15
26	— 631.28	+.14	+.01	—.22	—.03	.00	+.11	+.05	+.04	—.03	—.02
27	— 612.29	—.15	—.27	+.15		+.17	+.08				
28	— 610.82	+.07	—.40		+.18	+.33	+.05				—.22
29	— 598.37	+.11	—.05	—.26	—.07	—.04	.00	+.21	—.12	+.17	+.03
30	— 575.14	—.06	—.12	—.28	+.06	+.07	+.03	+.16	—.08	+.15	+.05
31	— 558.10	+.15	+.16	+.05	+.05	+.16	—.11	—.17	+.01	—.21	—.12
32	— 536.02		+.41	—.11	+.35	+.10	—.02	—.13			—.60
33	— 507.55	+.17	+.08	+.06	+.02	—.04	—.13	+.21	+.04	—.11	—.30
34	— 447.52	—.15	—.44		+.01	+.09	+.40	+.08	—.17	+.16	+.04
35	— 359.60	.00	—.03	+.29	—.17	—.17	+.02	+.08	—.10		+.08
36	— 344.69	—.37	+.44			+.20	—.22				—.07
37	— 318.45	+.15	—.10	—.23	+.08	+.24	—.08	—.05	—.12	+.22	—.14
38	— 282.49		+.08	+.06		—.03	—.08	—.05		—.07	+.10
39	— 233.90	—.02	+.03	—.01	+.16	+.17	+.03	—.03	—.06	—.42	+.20
40	— 167.17	—.03	—.11	—.07	+.14	—.07	+.03				+.13
41	— 117.75	—.09	+.32	—.05	+.05	—.18		+.22		—.27	
42	— 51.80	—.18	—.08	+.16	—.04	—.05	+.14	+.10	—.10	+.06	—.06
43	— 42.15	—.09	+.04	—.02	+.08	—.01	+.03	—.04	+.05	—.05	—.04
44	0.00	+.11	+.18	—.04	—.18	—.12	—.03	+.13	+.16	—.13	—.07
45	+ 18.18	+.14	—.10	—.03	+.01	+.01	.00	+.02	—.12	+.08	.00
46	+ 35.34	—.07	+.08	—.10	—.19		+.10				+.18
47	+ 56.41	—.11	+.02	—.04	+.04	—.02	+.14	—.06	—.09	+.04	+.09
48	+ 101.05	+.06	+.09	+.01	—.17	—.05	—.01	+.09	+.04	—.07	+.05

TABLE V.—71 CYGNI MEAN *Y* AND RESIDUALS FOR EACH PLATE.

Star.	Y_m	1	2	3	4	5	6	8	9	11	12
	″	″	″	″	″	″	″	″	″	″	″
1	— 117.91	+.17	+.10	—.02	—.12	—.01	—.02	—.14	+.01	+.03	—.06
2	+ 676.71	—.08	.00	+.16	—.20	—.02	+.02	+.02	+.12	—.03	.00
3	—1682.84	—.06	—.10	—.03	+.08	+.21	+.10		—.04	—.11	—.06
4	+1795.15	—.08	—.05	+.25						—.08	—.04
5	— 673.21	.00	—.18	+.01			—.05		—.03	+.09	+.16
6	+1071.19	—.13	—.12	+.01	—.03	—.06	+.02	+.11	—.07	+.26	—.01
7	— 556.41	—.05	+.03	—.12	+.07	+.05	.00	—.05	+.02	—.09	+.11
8	+1188.98	+.31	—.04	—.19	—.04	+.13	—.21	—.06	—.04	+.30	—.13
9	+ 814.74	+.12	+.04	+.01	+.06	+.02	—.13	—.13	.00	+.04	—.05
10	+ 651.66	—.02	—.09	+.14	—.07	+.03	—.05	—.10	.00	+.11	+.08
11	+1452.98	—.06	.00	—.04	—.01	+.05	+.04	—.02	.00	—.13	+.16
12	+ 303.52	—.01	—.04	+.04		.00	—.09	—.15	+.02	+.16	+.04
13	+ 362.16	—.06	+.03	+.04	+.10	+.18	.00	+.04	—.13	—.25	+.04
14	— 469.59	+.06	—.02	—.04	—.02	—.04	+.26	—.04		—.12	—.07
15	+1300.67	—.02	+.06	—.07	—.05	—.10	—.12	—.16	+.22	+.15	+.13
16	+1673.30	+.17	+.08	+.18		—.13	—.31		—.31		+.31
17	— 417.48	+.02	—.08	+.05	—.04	+.02	+.03	+.01	+.02	—.01	+.01
18	+ 724.61	—.10	—.03	+.04	+.16	—.02	+.04	—.07	—.11	+.02	+.08
19	+1041.35	+.09	+.06	—.11	+.07	+.03	—.03	—.22	—.02	+.03	+.11
20	—2038.64	—.14	—.09	—.01	+.03	+.18	+.15	.00	—.07	—.15	+.12
21	—2123.72	+.02	—.06	+.12	+.01		+.07	—.16			+.02
22	+1912.44	—.02	—.15			+.11		+.04			
23	+ 101.02	—.01	+.12	+.11	—.15	—.03	—.09	+.09	+.09	+.02	—.09
24	— 443.42	+.07	.00	.00	—.02	+.06	—.02	—.05	+.10	—.05	—.04
25	—1028.80	+.16	—.03	—.08	+.05	—.04	+.03	—.04	—.06	.00	—.04
26	+ 505.66	—.08	.00	—.01	+.08	.00	—.01	+.08	+.07	—.16	+.02
27	+1052.07	—.09	—.03	+.05		+.03	+.03				
28	+ 917.77	—.03	—.14		+.14	—.13	+.06				+.08
29	+1400.12	+.08	—.06	—.04	+.08	+.01	+.07	.00	—.06	—.10	+.04
30	+ 498.96	—.01	.00	.00	+.04	+.08	—.02	—.02	.00	—.05	—.04
31	—1229.89	—.10	+.03	—.14	+.15	—.05	—.03	—.06	+.02	+.16	+.04
32	+2028.74		+.50	—.30	+.07	—.32	—.12	—.05			+.20
33	+1995.44	—.18	—.02	—.12	+.04	—.07	+.15	—.14	—.03	+.29	+.03
34	+1972.05	+.16	—.02		+.02	—.12	—.28	—.26	+.17	+.25	+.12
35	+2084.71	—.21	+.10	—.13	+.18	—.19	+.17	+.17	—.14		+.04
36	+2066.27	+.21	+.04			—.17	+.35				—.45
37	— 35.21	.00	—.14	—.11	+.17	+.04	—.04	—.06	—.04	+.09	+.06
38	+ 968.50		—.17	+.29		—.08	.00	+.10		+.04	—.15
39	+1409.50	+.05	—.08	+.09	+.15	—.01	+.05	—.19	+.06	+.13	—.20
40	— 175.11	—.03	—.01	+.02	+.25	—.01	+.13				—.32
41	+2658.34	+.21	—.46	+.22	—.06	+.18		.00		—.07	
42	+2120.99	—.07	+.05	+.09	—.01	—.07	+.02	+.10	—.07	+.06	—.09
43	— 229.53	—.04	+.02	.00	+.10	—.04	+.03	+.05	—.07	—.05	.00
44	0.00	+.14	—.05	+.16	—.30	—.01	—.12	+.15	+.15	—.14	.00
45	+1290.14	+.01	+.04	—.04	+.02	—.09	—.06	+.12	.00	.00	—.02
46	+ 373.30	+.04	+.13	—.18	—.09		+.12				—.03
47	+2267.24	+.05	+.01	—.11	.00	+.04	+.20	—.06	—.01	—.22	+.10
48	— 399.15	+.10	—.04	+.04	—.18	.00	.00	+.16	.00	—.12	.00

TABLE V. — 71 CYGNI MEAN X AND RESIDUALS FOR EACH PLATE. — *Continued.*

Star.	X_m	1	2	3	4	5	6	8	9	11	12
	″	″	″	″	″	″	″	″	″	″	″
49	+ 109.41	+.01	−.01	−.12	+.08	.00	−.03	−.05	+.02	+.05	+.09
50	+ 108.69	−.34	−.02	.00	+.01	+.10	−.05	+.08	+.09		+.12
51	+ 134.64	−.15	−.22	−.30	−.10	+.07	−.20	+.15	+.22	+.12	+.39
52	+ 179.53	−.24	+.04		−.23	+.27	+.18				
53	+ 224.37		−.08	+.40	−.16	−.10	+.14	+.04	−.08	−.06	−.09
54	+ 237.70	+.26	−.30	−.10	+.09	+.10	−.07	+.03	−.21	+.16	+.07
55	+ 244.52	−.04	−.15	+.31	+.12	+.18	−.11	−.35	−.09	+.02	+.07
56	+ 337.76	+.29	−.16	−.14	+.08		+.10	−.13			−.01
57	+ 373.67	−.08	+.09	+.02	+.04	−.23		−.09	+.01	+.15	+.06
58	+ 379.55	−.11	−.50	+.58			−.10	+.11			
59	+ 552.70	−.07	+.04	+.11	−.12	−.15	+.12	+.02	+.07	+.04	−.08
60	+ 654.68	−.08	−.05	+.02	+.01	+.07	+.02	+.03	+.04	.00	−.07
61	+ 662.66	−.10	−.01	+.18	−.10	+.09	+.07	+.06	−.08	−.14	.00
62	+ 691.44	+.31	+.09	+.05	−.19		+.35	−.06	−.02	−.39	−.16
63	+ 813.62	.00	−.03	−.08	−.06	+.02	+.12	−.07			+.14
64	+1047.92		−.28	+.16	+.40	−.26					
65	+1150.36	−.26	+.18	−.26	+.07	+.05	−.03	+.03	−.10	+.17	+.14
66	+1245.79	−.22	−.22	−.09	+.14	−.04	−.09	+.22		+.24	+.05
67	+1256.96	−.11	+.06	+.01	−.03	−.20	−.15	+.14	+.19	+.18	−.06
68	+1450.25	+.10	−.04	+.15	−.07	+.06	−.09	−.10	−.07	−.03	+.04
69	+1671.05	+.04	−.10	+.24	+.07	+.05	+.04	+.03	+.14	−.48	.00
70	+1727.29	+.29	−.15	−.14							
71	+1733.13	+.21	+.14	−.20	−.02	−.21	+.04	−.03	+.16	−.03	−.03
72	+2331.65	.00	−.57	−.25		+.35	+.61	−.06	−.07		
73	+2858.38	−.25	−.22	−.08			+.54	−.01			
74	+2883.61	−.31	−.22	+.09			+.17	−.18	+.46		
75	+2996.03		−.10	−.19				+.29			
76	+3040.18		−.24	−.33			+.22	+.02			+.35
77	+3080.95	−.15	−.05	+.03				+.17			

TABLE V.—71 CYGNI MEAN Y AND RESIDUALS FOR EACH PLATE.—*Continued.*

Star.	Y_m	1	2	3	4	5	6	8	9	11	12
	″	″	″	″	″	″	″	″	″	″	″
49	—1459.92	—.04	+.09	+.07	+.02	+.06	—.04	+.04	—.10	—.05	—.04
50	+1461.28	+.03	—.03	+.24	—.13	—.19	+.13	+.09	+.02		—.16
51	—2357.15	—.13	—.05	—.15	—.07	—.18	+.02	+.11	+.12	+.23	+.12
52	— 918.19	+.03	+.02		+.10	+.01	—.15				
53	+2451.32		+.38	—.38	—.18	+.14	+.14	—.30	.00	+.49	—.32
54	+ 689.83	+.14	—.13	+.10	—.12	+.13	—.10	—.12	—.10	+.13	+.04
55	-- 723.11	+.02	+.06	—.05	+.11	—.08	+.14	—.04	—.02	—.13	—.02
56	— 263.44	+.04	.00	—.28	+.18		+.19	—.02			—.13
57	+2988.50	+.15	—.21	+.19	.00	—.05		—.07	—.27	+.09	+.18
58	+1814.31	—.05	—.22	—.11			+.18	+.22			
59	+2280.34	—.10	+.09	—.02	.00	+.09	+.01	+.02	.00	—.09	--.05
60	— 11.30	—.05	+.02	+.09	—.07	+.03	—.07	+.08	—.08	+.09	—.08
61	— 748.87	+.10	—.05	—.06	.00	+.03	—.03	+.08	—.08	—.01	—.02
62	—1570.59	—.09	+.15	+.17	—.01		+.10	+.22	—.16	—.39	+.04
63	— 946.71	+.16	+.02	—.51	+.13	+.11	+.05	+.18			—.11
64	+2977.58		—.06	—.18	+.12	+.11					
65	+ 211.72	—.19	+.02	—.04	—.06	—.15	+.11	+.09	+.21	+.01	+.04
66	—1198.43	+.19	+.13	+.08	—.16	—.07	.00	+.05		—.11	—.12
67	+2600.52	—.04	+.03	+.09	.00	—.10	+.09	+.05	—.06	—.02	—.03
68	+1031.48	—.02	+.09	—.06	+.05	—.05	+.04	+.09	—.06	+.01	—.04
69	+1752.09	—.01	+.02	+.11	+.02	--.12	+.03	+.14	.00	—.06	—.12
70	—2210.46	+.18	+.10	—.27							
71	—1017.64	+.08	+.12	+.17	—.08	+.02	—.07	+.08	+.05	--.24	—.19
72	+1997.55	.00	+.36	—.01		—.52	+.16	—.03	+.05		
73	+1210.88	+.04	+.32	—.18			—.27	+.09			
74	+1411.30	+.15	+.04	—.16			+.07	+.06	—.13		
75	— 711.38		+.05	—.08				+.03			
76	—1958.18		+.25	+.26			—.17	+.21			—.56
77	— 262.51	—.01	—.07	—.19				+.27			

TABLE VI.—71 CYGNI CONCORDANCE WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.

Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.	Photo. No.	No. in A. G. Cat.
1	15459	15	15522	30	15559	59	15601
2	15474	17	15530	33	15562	60	15604
3	15475	18	15531	35	15571	61	15605
6	15487	19	15532	41	15580	67	15629
9	15491	23	15542	44	15583	69	15647
10	15500	24	15545	48	15586	71	15651
11	15502	25	15551	49	15588	76	15692
12	15514	26	15558	51	15589		

TABLE VII.—71 CYGNI COMPARISON WITH ASTRONOMISCHE GESELLSCHAFT CATALOG.[1]

$p = +0.000428 \quad \pm 0.000072$

$r = -0.000023 \quad \pm 0.000072$

$k = +1''.063 \quad \pm 0''.146$

$c = +0''.411 \quad \pm 0''.146$

Probable error of a single equation = ± 0.7495

RESIDUALS.

Star.	v_x	v_y	Star.	v_x	v_y
	″	″		″	″
1	−0.10	−1.42	26	−0.74	+0.08
2	+1.51	−0.04	30	+0.44	+1.04
3	−0.30	−0.10	33	--0.27	−0.23
6	−0.69	−1.87	35	+0.35	+1.20
9	−1.18	+0.38	41	−0.29	+1.31
10	+0.71	−0.42	44	+1.06	+0.41
11	+0.57	−0.22	49	−0.83	−0.44
12	−1.00	+0.42	51	−2.96	−2.09
15	+1.34	−0.22	59	−0.33	+0.05
17	−0.40	−0.37	60	−0.18	+0.84
18	+2.69	−1.68	61	−1.41	+1.63
19	−2.25	−0.56	67	+1.15	+0.17
23	+0.66	−0.30	69	−0.56	+0.60
24	+1.59	+0.79	71	+1.26	+0.81
25	+1.50	+0.94	76	−1.34	−0.69

---

[1] Star 48 was omitted because the A. G. C. place seems to be incorrect.

TABLE VIII. — 71 CYGNI FINAL COÖRDINATES.

Star.	*X*	*Y*	Star.	*X*	*Y*
1	−2839″.45	− 117″.62	40	− 166″.17	− 174″.77
2	−2554.42	+ 677.35	41	− 116.80	+2659.99
3	−2580.72	−1683.21	42	− 50.81	+2122.31
4	−2393.50	+1796.27	43	− 41.10	− 229.22
5	−2294.25	− 673.14	44	+ 1.06	+ 0.41
6	−2262.45	+1072.01	45	+ 19.22	+1291.10
7	−2194.39	− 556.29	46	+ 36.41	+ 373.87
8	−2109.16	+1189.86	47	+ 57.45	+2268.62
9	−2084.00	+ 815.45	48	+ 102.17	− 398.91
10	−1815.25	+ 652.31	49	+ 110.56	−1460.13
11	−1768.74	+1453.97	50	+ 190.77	+1462.32
12	−1607.62	+ 304.02	51	+ 135.81	−2357.74
13	−1579.05	+ 362.69	52	+ 180.70	− 918.17
14	−1451.22	− 469.42	53	+ 225.47	+2452.78
15	−1430.52	+1301.61	54	+ 238.85	+ 690.54
16	−1279.59	+1674.40	55	+ 245.70	− 723.00
17	−1200.08	− 417.27	56	+ 338.98	− 263.14
18	−1188.15	+ 725.31	57	+ 374.82	+2990.20
19	−1183.31	+1042.18	58	+ 380.73	+1815.51
20	−1184.32	−2039.13	59	+ 553.94	+2281.74
21	−1078.43	−2124.24	60	+ 656.02	− 10.88
22	− 985.30	+1913.64	61	+ 664.02	− 748.77
23	− 947.88	+ 101.46	62	+ 692.83	−1570.83
24	− 871.10	− 443.21	63	+ 815.06	− 946.68
25	− 779.88	−1028.85	64	+1049.37	+2979.29
26	− 630.49	+ 506.27	65	+1151.91	+ 212.25
27	− 611.52	+1052.92	66	+1247.41	−1198.50
28	− 610.04	+ 918.56	67	+1258.50	+2602.07
29	− 597.60	+1401.12	68	+1451.91	+1032.37
30	− 574.34	+ 499.57	69	+1672.79	+1753.29
31	− 557.25	−1230.02	70	+1729.14	−2210.95
32	− 535.23	+2030.00	71	+1734.96	−1017.63
33	− 506.75	+1996.69	72	+2333.67	+1998.87
34	− 446.69	+1973.30	73	+2860.64	+1211.87
35	− 358.74	+2086.00	74	+2885.88	+1412.39
36	− 343.82	+2067.55	75	+2998.39	− 711.20
37	− 317.52	− 34.82	76	+3042.59	−1958.54
38	− 281.57	+ 969.32	77	+3083.34	− 262.14
39	− 232.96	+1410.51			

TABLE IX.—71 CYGNI DIAMETERS OF STAR-IMAGES.

Star.	Diameter.	Star.	Diameter.	Star.	Diameter.	Star.	Diameter.
	r		r		r		r
1	0.178	21	0.134	41	0.157	61	0.128
2	0.281	22	0.122	42	0.130	62	0.156
3	0.173	23	0.219	43	0.139	63	0.146
4	0.154	24	0.142	44	0.215	64	0.145
5	0.138	25	0.126	45	0.142	65	0.132
6	0.136	26	0.130	46	0.109	66	0.133
7	0.134	27	0.113	47	0.135	67	0.172
8	0.120	28	0.131	48	0.210	68	0.136
9	0.142	29	0.128	49	0.167	69	0.138
10	0.153	30	0.136	50	0.104	70	0.165
11	0.172	31	0.115	51	0.136	71	0.196
12	0.123	32	0.129	52	0.114	72	0.170
13	0.129	33	0.142	53	0.139	73	0.171
14	0.129	34	0.122	54	0.110	74	0.153
15	0.158	35	0.140	55	0.125	75	0 143
16	0.142	36	0.141	56	0.136	76	0.238
17	0.153	37	0.118	57	0.161	77	0.177
18	0.146	38	0.121	58	0.111		
19	0.135	39	0.133	59	0.153		
20	0.135	40	0.115	60	0.148		

TABLE X.—71 CYGNI FINAL CATALOG.

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Preces-sion.	Secular Varia-tion.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
1	7.8	10	21 20 17.982	320 4 29.73	+2.1852	+32.7782	+0.0059	+0.0883	45 57 5.88	+15.3792	+0.1979	1876.15
2	6.5	10	21 20 44.326	320 11 4.88	2.1804	32.7054	0.0059	0.0887	46 10 24.57	15.4039	0.1970	76.15
3	7.9	9	21 20 44.712	320 11 10.68	2.2006	33.0087	0.0060	0.0898	45 31 4.08	15.4042	0.1989	76.10
4	8.3	5	21 20 58.509	320 14 37.63	2.1717	32.5760	0.0059	0.0886	46 29 5.30	15.4171	0.1959	76.12
5	8.6	7	21 21 10.859	320 17 42.89	2.1940	32.9098	0.0060	0.0901	45 47 57.44	15.4286	0.1978	76.16
6	8.6	10	21 21 11.994	320 17 59.92	+2.1791	+32.6861	+0.0060	+0.0893	46 17 2.72	+15.4297	+0.1964	76.15
7	8.7	10	21 21 20.284	320 20 4.26	2.1937	32.9056	0.0060	0.0904	45 49 55.40	15.4374	0.1976	76.15
8	9.0	10	21 21 26.659	320 21 39.89	2.1792	32.6879	0.0060	0.0897	46 19 2.25	15.4434	0.1961	76.15
9	8.5	10	21 21 29.466	320 22 21.99	2.1826	32.7397	0.0060	0.0900	46 12 48.17	15.4460	0.1964	76.15
10	8.3	10	21 21 55.499	320 28 52.48	2.1861	32.7908	0.0061	0.0908	46 10 7.69	15.4701	0.1962	76.15
11	8.0	10	21 21 59.286	320 29 49.28	+2.1794	+32.6914	+0.0060	+0.0905	46 23 29.69	+15.4736	+0.1955	76.15
12	9.0	9	21 22 15.754	320 33 56.31	2.1906	32.8592	0.0061	0.0916	46 4 21.21	15.4889	0.1963	76.18
13	8.8	10	21 22 18.455	320 34 36.83	2.1903	32.8548	0.0061	0.0916	46 5 20.12	15.4915	0.1962	76.15
14	8.8	9	21 22 31.324	320 37 49.85	2.1984	32.9760	0.0062	0.0924	45 51 29.02	15.5034	0.1967	76.10
15	8.2	10	21 22 32.080	320 38 1.20	2.1833	32.7497	0.0061	0.0916	46 21 0.09	15.5040	0.1953	76.15
16	8.5	7	21 22 46.422	320 41 36.33	+2.1812	+32.7182	+0.0061	+0.0918	46 27 13.88	+15.5173	+0.1948	76.02
17	8.3	10	21 22 55.333	320 43 49.99	2.1998	32.9970	0.0062	0.0931	45 52 22.83	15.5255	0.1964	76.15
18	8.4	10	21 22 55.820	320 43 57.30	2.1901	32.8518	0.0062	0.0926	46 11 25.44	15.5260	0.1955	76.15
19	8.7	10	21 22 56.104	320 44 1.55	2.1874	32.8114	0.0062	0.0924	46 16 42.33	15.5262	0.1952	76.15
20	8.7	10	21 22 57.755	320 44 26.33	2.2136	33.2041	0.0063	0.0938	45 25 21.19	15.5278	0.1976	76.15
21	8.7	7	21 23 7.855	320 46 57.83	+2.2151	+33.2261	+0.0063	+0.0941	45 23 56.67	+15.5371	+0.1976	76.01
22	9.0	4	21 23 14.782	320 48 41.74	2.1814	32.7207	0.0062	0.0926	46 31 14.81	15.5435	0.1943	75.92
23	7.2	10	21 23 19.243	320 49 48.65	2.1973	32.9588	0.0062	0.0936	46 1 2.90	15.5475	0.1957	76.15
24	8.5	10	21 23 26.841	320 51 42.62	2.2024	33.0367	0.0063	0.0940	45 51 58.59	15.5545	0.1960	76.15
25	8.9	10	21 23 35.793	320 53 56.90	2.2081	33.1211	0.0063	0.0945	45 42 13.35	15.5628	0.1964	76.15

TABLE X.—71 CYGNI FINAL CATALOG.—*Continued.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
26	8.8	10	21 23 49.588	320 57 23.83	+2.1962	+32.9428	+0.0063	+0.0943	46 7 48.97	+15.5755	+0.1950	1876.15
27	9.2	5	21 23 51.252	320 57 48.78	2.1917	32.8748	0.0063	0.0941	46 16 55.66	15.5770	0.1946	75.72
28	8.8	6	21 23 51.434	320 57 51.51	2.1928	32.8923	0.0063	0.0942	46 14 41.31	15.5772	0.1947	75.97
29	8.8	10	21 23 52.493	320 58 7.39	2.1888	32.8315	0.0063	0.0940	46 22 43.89	15.5781	0.1943	76.15
30	8.6	10	21 23 54.992	320 58 44.89	2.1967	32.9501	0.0063	0.0945	46 7 42.44	15.5805	0.1950	76.15
31	9.2	10	21 23 57.099	320 59 16.48	+2.2114	+33.1709	+0.0063	+0.0952	45 38 52.93	+15.5824	+0.1963	76.15
32	8.8	7	21 23 58.354	320 59 35.31	2.1838	32.7574	0.0063	0.0938	46 33 12.91	15.5835	0.1938	76.06
33	8.5	10	21 24 1.124	321 0 16.86	2.1843	32.7650	0.0063	0.0940	46 32 39.67	15.5861	0.1938	76.15
34	9.0	9	21 24 6.950	321 1 44.25	2.1850	32.7750	0.0063	0.0941	46 32 16.43	15.5914	0.1937	76.21
35	8.6	9	21 24 15.454	321 3 51.81	2.1847	32.7707	0.0063	0.0944	46 34 9.30	15.5992	0.1935	76.06
36	8.5	5	21 24 16.904	321 4 13.55	+2.1850	+32.7747	+0.0063	+0.0944	46 33 50.88	+15.6005	+0.1935	75.98
37	9.1	10	21 24 19.778	321 4 56.67	2.2031	33.0469	0.0064	0.0954	45 58 48.62	15.6031	0.1951	76.15
38	9.0	7	21 24 23.091	321 5 46.36	2.1949	32.9231	0.0063	0.0951	46 15 32.82	15.6062	0.1943	76.20
39	8.7	10	21 24 27.727	321 6 55.90	2.1915	32.8722	0.0063	0.0950	46 22 54.05	15.6105	0.1939	76.15
40	9.2	7	21 24 34.310	321 8 34.64	2.2054	33.0815	0.0064	0.0959	45 56 28.86	15.6165	0.1951	75.92
41	8.2	7	21 24 38.882	321 9 43.22	+2.1816	+32.7244	+0.0063	+0.0948	46 43 43.41	+15.6207	+0.1928	76.01
42	8.8	10	21 24 45.312	321 11 19.68	2.1868	32.8017	0.0063	0.0952	46 34 45.93	15.6266	0.1932	76.15
43	8.6	10	21 24 46.301	321 11 34.51	2.2068	33.1026	0.0064	0.0963	45 55 34.48	15.6274	0.1950	76.15
44	7.3	10	21 24 50.342	321 12 35.13	2.2052	33.0784	0.0064	0.0964	45 59 24.11	15.6312	0.1948	76.15
45	8.5	10	21 24 52.096	321 13 1.44	2.1944	32.9165	0.0064	0.0958	46 20 54.78	15.6327	0.1937	76.15
46	9.3	6	21 24 53.740	321 13 26.10	+2.2023	+33.0351	+0.0064	+0.0963	46 5 37.56	+15.6342	+0.1944	75.92
47	8.7	10	21 24 55.815	321 13 57.23	2.1864	32.7954	0.0064	0.0955	46 37 12.22	15.6361	0.1929	76.15
48	7.4	10	21 25 0.024	321 15 0.36	2.2093	33.1400	0.0065	0.0968	45 52 44.76	15.6400	0.1950	76.15
49	8.0	10	21 25 0.771	321 15 11.57	2.2182	33.2733	0.0065	0.0972	45 35 3.56	15.6406	0.1957	76.15
50	9.4	9	21 25 0.851	321 15 12.76	2.1937	32.9051	0.0064	0.0960	46 23 45.96	15.6408	0.1935	76.06

TABLE X.—71 CYGNI FINAL CATALOG.—*Concluded.*

No.	Mag.	No. of Plates.	Right Ascension 1875.0		Precession.		Secular Variation.		Declination 1875.0	Precession.	Secular Variation.	Mean Epoch.
			In Time.	In Arc.	In Time.	In Arc.	In Time.	In Arc.				
			h m s	° ′ ″	s	″	s	″	° ′ ″	″	″	
51	8.6	10	21 25 3.120	321 15 46.79	+2.2258	+33.3871	+0.0065	+0.0975	45 20 6.01	+15.6428	+0.1964	1876.15
52	9.2	5	21 25 7.499	321 16 52.48	2.2143	33.2138	0.0065	0.0972	45 44 5.46	15.6468	0.1953	75.78
53	8.6	9	21 25 12.144	321 18 2.16	2.1861	32.7914	0.0064	0.0959	46 40 16.24	15.6510	0.1926	76.21
54	9.3	10	21 25 13.238	321 18 18.57	2.2012	33.0181	0.0065	0.0968	46 10 54.09	15.6520	0.1940	76.15
55	8.9	10	21 25 13.731	321 18 25.96	2.2131	33.1967	0.0065	0.0973	45 47 20.55	15.6525	0.1950	76.15
56	8.6	7	21 25 22.723	321 20 40.84	+2.2100	+32.1496	+0.0065	+0.0974	45 55 0.28	+15.6607	+0.1946	76.01
57	8.2	9	21 25 26.752	321 21 41.29	2.1826	33.7396	0.0064	0.0961	46 49 13.33	15.6644	0.1920	76.18
58	9.2	5	21 25 27.108	321 21 46.62	2.1928	32.8913	0.0064	0.0967	46 29 38.80	15.6647	0.1929	75.85
59	8.3	10	21 25 44.008	321 26 0.12	2.1901	32.8520	0.0065	0.0970	46 37 24.55	15.6801	0.1924	76.15
60	8.4	10	21 25 53.183	321 28 17.75	2.2103	33.1539	0.0065	0.0982	45 59 11.74	15.6884	0.1940	76.15
61	8.8	10	21 25 53.716	321 28 25.74	+2.2165	+33.2468	+0.0066	+0.0985	45 46 53.84	+15.6889	+0.1946	76.15
62	8.2	9	21 25 56.198	321 29 2.98	2.2234	33.3516	0.0066	0.0989	45 33 11.72	15.6911	0.1952	76.18
63	8.4	8	21 26 8.077	321 32 1.15	2.2192	33.2884	0.0066	0.0990	45 43 35.38	15.7019	0.1946	76.00
64	8.5	4	21 26 32.456	321 38 6.84	2.1881	32.8212	0.0065	0.0982	46 48 59.94	15.7240	0.1913	75.75
65	8.7	10	21 26 40.885	321 40 13.27	2.2122	33.1828	0.0066	0.0996	46 2 52.62	15.7316	0.1933	76.15
66	8.7	9	21 26 49.215	321 42 18.22	+2.2245	+33.3680	+0.0067	+0.1004	45 39 21.35	+15.7392	+0.1943	76.10
67	8.0	10	21 26 52.591	321 43 8.87	2.1930	32.8944	0.0066	0.0990	46 42 41.56	15.7422	0.1914	76.15
68	8.6	10	21 27 10.276	321 47 34.13	2.2077	33.1152	0.0067	0.1002	46 16 30.72	15.7582	0.1924	76.15
69	8.6	10	21 27 32.166	321 53 2.49	2.2034	33.0507	0.0067	0.1006	46 28 29.81	15.7779	0.1916	76.15
70	8.1	3	21 27 34.328	321 53 34.92	2.2363	33.5450	0.0068	C.1020	45 22 25.49	15.7798	0.1945	75.60
71	7.6	10	21 27 35.861	321 53 57.91	+2.2267	+33.4009	+0.0068	+0.1017	45 42 18.60	+15.7812	+0.1936	76.15
72	8.0	7	21 28 36.411	322 9 6.16	2.2066	33.0984	0.0068	0.1026	46 32 28.58	15.8356	0.1906	75.97
73	8.0	5	21 29 26.368	322 21 35.53	2.2172	33.2584	0.0070	0.1045	46 19 14.79	15.8802	0.1906	75.85
74	8.3	6	21 29 29.087	322 22 16.30	2.2158	33.2367	0.0070	0.1045	46 22 34.88	15.8826	0.1905	75.98
75	8.5	3	21 29 36.880	322 24 13.19	2.2339	33.5082	0.0070	0.1054	45 47 10.11	15.8895	0.1919	75.92
76	7.0	5	21 29 39.302	322 24 49.53	+2.2442	+33.6623	+0.0071	+0.1058	45 26 22.44	+15.8916	+0.1928	76.12
77	7.9	4	21 29 45.661	322 26 24.91	2.2309	33.4638	0.0070	0.1055	45 54 37.77	15.8973	0.1915	75.84

LIST OF

CONTRIBUTIONS FROM THE OBSERVATORY OF COLUMBIA UNIVERSITY, NEW YORK.

LISTS OF ERRATA IN CONTRIBUTIONS FROM THE OBSERVATORY OF COLUMBIA UNIVERSITY WILL BE FOUND IN CONTRIBUTIONS 19, p. 68, and 24, p. 74.

No. 1. LEWIS MORRIS RUTHERFURD, BY JOHN K. REES. Pp. 15. July, 1906. *Octavo.*

No. 2. A CATALOGUE OF RUTHERFURD'S PHOTOGRAPHIC PLATES OF THE SUN, THE MOON AND THE STARS, BY JOHN K. REES. Pp. 7. July, 1906. *Octavo.*

No. 3. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THE GROUP OF THE PLEIADES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. VI., pp. 239–330. February, 1892. *Octavo.*

No. 4. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF THE STARS ABOUT β CYGNI, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. VI., pp. 331–348. May, 1892. *Octavo.*

No. 5. THE PARALLAXES OF μ AND θ CASSIOPEIÆ DEDUCED FROM RUTHERFURD PHOTOGRAPHIC MEASURES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. VIII., pp. 1–23. March, 1893. *Octavo.*

No. 6. THE PARALLAX OF η CASSIOPEIÆ DEDUCED FROM THE RUTHERFURD PHOTOGRAPHIC MEASURES, BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences, Vol. VIII., pp. 301–321. April, 1895. *Octavo.*

No. 7. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF SIXTY-TWO STARS ABOUT η CASSIOPEIÆ, BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences, Vol. VIII., pp. 381–416. June, 1895. *Octavo.*

No. 8. DECLINATIONS AND PROPER MOTIONS OF FIFTY-SIX STARS, BY HERMAN S. DAVIS, PH.D. Memoir I., Part 1, New York Academy of Sciences, pp. 105. June, 1895. *Quarto.*

No. 9. THE VARIATION OF LATITUDE AT NEW YORK CITY FROM OBSERVATIONS BY JOHN K. REES, HAROLD JACOBY AND HERMAN S. DAVIS. MEMOIR I., Part 2, New York Academy of Sciences, pp. 236. July, 1906. *Quarto*

No. 10. ON THE REDUCTION OF STELLAR PHOTOGRAPHS, WITH SPECIAL REFERENCE TO THE ASTRO-PHOTOGRAPHIC CATALOGUE PLATES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. IX., pp. 101–123. April, 1896. *Octavo.*

No. 11. ON THE PERMANENCE OF THE RUTHERFURD PHOTOGRAPHIC PLATES, BY HAROLD JACOBY. Annals of the New York Academy of Sciences, Vol. IX., pp. 195–284. October, 1896. *Octavo.*

No. 12. THE RUTHERFURD PHOTOGRAPHIC MEASURES OF SIXTY-FIVE STARS NEAR 61 CYGNI, BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences. Vol. X., pp. 58–121. August, 1897. *Octavo.*

No. 13. THE PARALLAXES OF 61^1 AND 61^2 CYGNI DEDUCED FROM THE RUTHERFURD PHOTOGRAPHIC MEASURES, BY HERMAN S. DAVIS. Annals of the New York Academy of Sciences, Vol. X., pp. 123–160. August, 1897. *Octavo.*

No. 14. The Rutherfurd Photographic Measures of Thirty-Four Stars near "Bradley 3077," by Herman S. Davis. Annals of the New York Academy of Sciences, Vol. X., pp. 161–187. August, 1897. *Octavo.*

No. 15. The Præsepe Group; Measurement and Reduction of the Rutherfurd Photographs, by Frank Schlesinger. Annals of the New York Academy of Sciences, Vol. X., pp. 188–286. May, 1898. *Octavo.*

No. 16. The Positions and Proper Motions of the Principal Stars in the Cluster of Coma Berenices as Deduced from Measurements of the Rutherfurd Photographs, by Walter C. Kretz. Annals of the New York Academy of Sciences, Vol. XII., pp. 342–478. February, 1900. *Octavo.*

No. 17. The Rutherfurd Photographic Measures of the Group of the Pleiades (Second Paper), by Harold Jacoby. Pp. 24, January, 1901. *Octavo.*

No. 18. The Parallax of μ Cassiopeiæ and the Positions of 56 Neighboring Stars as Deduced from the Rutherfurd Photographic Measures, by George N. Bauer. Pp. 102. April, 1901. *Octavo.*

No. 19. Catalogue of 287 Stars Near the South Pole, and Optical Distortion of the Cape of Good Hope Astro-Photographic Telescope, by Harold Jacoby. Pp. 70. April, 1902. *Octavo.*

No. 20. The Sumatra Eclipse, 1901. Spectrographic Study of the Flash Spectrum: New Gases in the Sun, by S. A. Mitchell. Pp. 42. November, 1903. *Octavo.*

No. 21. Photographic Catalogue of 829 Stars near the South Pole of the Heavens; An Example of Inter-Adjusting Overlapping Plates, by Harold Jacoby. Pp. 153. January, 1904. *Octavo.*

No. 22. Researches as to the Identity of the Periodic Comet of 1889–1896–1903 (Brooks) with the Periodic Comet of 1770 (Lexell), by Charles Lane Poor. Pp 82. December, 1904. *Octavo.*

No. 23. Tables for the Reduction of Astronomical Photographs, by Harold Jacoby. Pp. 24. February, 1905. *Octavo.*

No. 24. Rutherfurd Photographs of the Stellar Clusters h and χ Persei by Anne Sewell Young. Pp. 76. September, 1906. *Octavo.*

No. 25. Rutherfurd Photographs of Stars Surrounding 59 Cygni, by Harold Jacoby. Pp. 23. April, 1908. *Octavo.*

No. 26. An Investigation of the Figure of the Sun and of Possible Variations in its Size and Shape, by Charles Lane Poor. Annals of The New York Academy of Sciences, Vol. XVIII, No. 9, Part III, pp. 385-424. August, 1908. *Octavo.*

No. 27. Rutherfurd Photographs of Stars Surrounding β Cygni, by Morris Francis Weinrich. Pp. 34. April, 1909. *Octavo.*

No. 28. Rutherfurd Photographs of Stars Surrounding η, 27, 34, γ, ν and 71 Cygni, by Harold Jacoby. Pp. 115. October, 1910. *Octavo.*

* Contributions numbered 1 to 7 and 10 to 15 (inclusive) have been gathered together in a volume of 614 pages entitled Rutherfurd: Stellar Photographs: Vol. I.; Pleiades: Cygnus: Cassiopeiæ: Præsepe, by Rees, Jacoby, Davis and Schlesinger, 1898.

The volume is supplied with a consecutive pagination, table of contents and a preface.

Only a few volumes have been distributed because of the scarcity of several of the papers.

Beginning with No. 16 all contributions relating to the Rutherfurd Photographs will be paged consecutively at the bottom of the pages, and in due time will be assembled in a second Rutherfurd volume.

.tron.
bs.
[illegible]
[illegible] c

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—NO. 29
HAROLD JACOBY, DIRECTOR

THE FIELD OF 61 CYGNI

A STUDY OF YERKES OBSERVATORY PARALLAX PHOTOGRAPHS

BY

MARY MURRAY HOPKINS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN THE FACULTY OF PURE SCIENCE,
COLUMBIA UNIVERSITY

NEW YORK
1915

CONTRIBUTIONS FROM THE OBSERVATORY OF
COLUMBIA UNIVERSITY—NO. 29
HAROLD JACOBY, DIRECTOR

THE FIELD OF 61 CYGNI

A STUDY OF YERKES OBSERVATORY PARALLAX PHOTOGRAPHS

BY

MARY MURRAY HOPKINS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN THE FACULTY OF PURE SCIENCE,
COLUMBIA UNIVERSITY

NEW YORK
1915

PRESS OF
THE NEW ERA PRINTING COMPANY
LANCASTER, PA

Exch.
Columbia Univ. Observatory
6-12-1929

PREFATORY NOTE.

The stellar photographs discussed in the present memoir were made with the 40-inch refractor at the Yerkes Observatory and measured there by the author. The reduction has been completed at Columbia University.

The cost of publication has been met from the Bruce fund.

HAROLD JACOBY,
Rutherfurd Professor of Astronomy and
Director of the Observatory.

COLUMBIA UNIVERSITY,
September, 1915.

CONTENTS.

I. Introduction.

PAGE.
1. Description of plates—Table I 1
2. Purpose of the study 2
3. The measuring machine 3
4. Measurement of plates 3
5. Instrumental corrections to measures 4
6. Table II—Measured coördinates (corrected) 5

II. Proper motion.

1. Relations between the plates 10
2. Derivation of proper motions 11
3. Proper motion of 61^1 and 61^2 Cygni 13
4. Table III—Proper motions 14

III. Parallax.

1. Parallax factor 16
2. Solution of plates 17
3. Table IV—Parallax of 61^1 and 61^2 Cygni, and star 9 20

IV. Catalog.

1. Analysis of procedure 23
2. Right ascensions and declinations transformed to ideal coördinates 23
3. Plate constants—measured coördinates transformed to ideal. 24
4. Table V—Ideal coördinates 29
5. Right ascensions and declinations derived from ideal coördinates 31
6. Table VI—Catalog of positions 33

V. The parallax of 61 Cygni.

1. Historical notes 35
2. Table VII—Values of parallax of 61 Cygni 39
3. Remarks 43

I. INTRODUCTION.

1. **Description of the Plates.**—The plates which form the basis for the following study of the field of 61 Cygni were taken with the 40-inch refractor of the Yerkes Observatory as part of the parallax program inaugurated by Dr. Frank Schlesinger.[1] The plates are 8 × 10 inches (20 × 25 cm.) representing approximately 35 × 45 minutes of arc. One millimetre on the plates corresponds to 10″.6+, the focal length of the telescope being 19.36 metres. There is no réseau on the plates.

The writer measured the plates specified in the following table at the Yerkes Observatory during the summer of 1913.

TABLE I.—LIST OF PLATES.

Plate.	Date.	Images.	Length of Exposure.	Hour Angle.	Observers.
414	Aug. 7, 1904	1	5 min.	h +1.2	Schlesinger
		2	5		
		3	5		
415	Aug. 7, 1904	1	5	+1.8	Schlesinger
		2	5		
		3	5		
π 515	Oct. 7, 1911	1	6	−0.4	Sullivan
		2	6		Van Maanen
π 534	Oct. 28, 1911	1	6	−0.3	Slocum
		2	6		
π 778	June 8, 1912	1	5	−0.7	Sullivan
		2	5		Slocum
π 785	June 9, 1912	1	6	−0.3	Mitchell
		2	6		Sullivan
π 966	Oct. 27, 1912	1	10	−0.3	Slocum
		2	10		Mitchell
π 982	Nov. 9, 1912	1	10	−0.2	Slocum
		2	10		Mitchell
π 1263	June 21, 1913	1	6	−0.6	Slocum
		2	6		Sullivan
π 1270	June 22, 1913	1	6	−0.6	Sullivan
		2	6		Mitchell

The telescope was west of the pier for all exposures.

---

[1] Photographic Determinations of Stellar Parallax made with the Yerkes Refractor by Frank Schlesinger under the auspices of The Carnegie Institution, *Astrophysical Journal*, Vol. XXXII, No. 5, 1910; XXXIII, No. 1, 2, 3, 4, 5, 1911; XXXIV, No. 1, 1911.

With the exception of π515 and π534 which were marked "fair," these plates were marked "good" at the time of developing. The first two plates were taken without a color-screen; the later ones through a yellow color-filter.[1] The images on plates 414 and 415 are decidedly less definite in outline than the images on the other 8 plates taken with the screen.

Using 120 settings of the micrometer wire on images marked "good" while measuring but otherwise chosen at random, it is found that the probable error of a single setting of the micrometer wire is a little larger for plates 414 and 415 than for the others, as is to be expected.

From images on plates 414 and 415—probable error of a setting = $\pm''.016$.

From images on later plates—probable error of a setting = $\pm''.013$.

A rotating disc[2] designed by Schlesinger was used when the plate was exposed to reduce the brightness of the central star, 61 Cygni, by approximately 3½ magnitudes, so that the images of its components are not larger than the images of some of the other stars.

2. **Purpose of the Study.**—The initial purpose of the measures was to find any appreciable proper motions that might exist among the faint stars very near 61 Cygni. To this end the two earliest and two latest plates available were chosen. The measures were extended to other plates of late date, first with the object of increasing the number of stars for the proper motion study and second to provide material for determining (*a*) the parallax of any star that might prove to have appreciable proper motion and (*b*) the parallax of 61 Cygni itself. These measures also made possible the construction of a catalog of the positions of 57 of the stars.

On plates π515 and π785 only a few stars were measured and in the X direction only, to serve as comparison stars for finding the parallax of 61 Cygni. On the other eight plates every distinct image was measured.

---

[1] *Astrophysical Journal*, Vol. XXXVIII, No. 1, Frederick Slocum and S. A. Mitchell.

[2] Schlesinger, Photo. Determ., p. 13.

3. **The Measuring Machine.**—The machine[1] used in measuring these plates was constructed by Gaertner and Co., of Chicago. The micrometer screw has a pitch of half a millimetre. The distance from the microscope objective to the film of the plate when in position for measuring is twice the distance from the objective to the cross-wires. Consequently 4 turns of the screw correspond to 1 mm. on the plate. Since 1 mm. = $10''.6+$,[2] 1 turn of the screw corresponds to $2''.66$ for these plates. The micrometer head is graduated into 100 parts and tenths of these parts were estimated and recorded.

The scale is of German silver. The graduations consist of two fine lines separated by about 0.12 mm. The micrometer wire apparently nearly fills this space and when making a setting the narrow bright strips on either side of the wire, between it and the graduation lines, can be made very accurately equal. The division errors of the scale were determined at the U. S. Bureau of Standards.[3]

4. **Measurement of the Plates.**—The plates were measured in rectangular coördinates, the direction of increasing right ascension taken as the direction of increasing *X* coördinate, the direction of increasing declination, the increasing *Y* coördinate. The measures of the images were made and recorded according to the following routine: two settings on the star; microscope tilted to view the scale; two settings on the scale; microscope lowered; two settings on the star.

Star.	Scale.
0.002	Line *476*
.008	0.929
.008	.928
.018	
	0.928
0.009	476.919 (Measure)

The wire was moved completely off the image or graduation between each two settings. The scale graduation used was always the next lower one; *i. e.*, the one that appeared at the right of the thread when the microscope was tilted from viewing the star image to the scale.

---

[1] Schlesinger, Photo. Determ., Plate II, p. 16.

[2] See p. 1.

[3] Schlesinger, Photo. Determ., Table II, p. 26.

When the two, or in the case of the plates 414 and 415 three, images of each star had been measured for X direct, the plate was turned through 180° and X reversed was measured. The Y coördinate was measured similarly. The mean of direct and reversed measures, reduced to direct, for the two or three images, has been called the *measure* for the star. The reduction of reversed to direct was made for each exposure separately.

The first plate measured, π982, was oriented in the measuring machine by using stars 19[1] (A. G., Lund, No. 9886) and 39 (A. G., No. 9900) and the other plates were set in the machine so that the X coördinate of the western, or A, image of each star was approximately the same.

5. **Instrumental Corrections.**—The measure for each star must be corrected for (*a*) division errors of the scale and (*b*) for runs. The division errors of the scale were taken from the table published by Schlesinger.[2]

Measures for runs were taken at five points along the scale on each day that measurements were made. On no day did the maximum possible correction to be applied to a measure equal the probable error of a single setting on a star image. The correction for runs was therefore considered zero for each day.

Other possible sources of instrumental errors in the measures are (*a*) deviations of the guiding way on which the plate carriage runs, from perfect straightness, (*b*) incorrect collimation of the micrometer microscope, (*c*) periodic and (*d*) progressive errors of the micrometer screw. All of these are negligible for the measures here discussed.[3]

Table II gives the measured coördinates corrected for scale errors.

---

[1] Numbers of stars are given to correspond to the current number in the catalog, p. 33.

[2] Schlesinger, Photo. Determ., p. 26.

[3] *Ibid.*, pp. 27, 28.

TABLE II.—MEASURED COÖRDINATES (CORRECTED).

Unit = 1 turn of micrometer screw = 2″.66.

Number in Catalog.	Number on Plate.	Plate 414.		Number in Catalog.	Number on Plate.	Plate 415.	
		X	*Y*			*X*	*Y*
1	1	99.226	272.988	1	1	97.978	274.264
2	3_1	96.738	566.960	2	3_1	95.454	568.234
3	2	98.700	448.496	3	2	97.437	449.778
4	4_1	95.388	751.058	4	4_1	94.114	752.359
7	6	138.097	564.990	5	4_2	94.985	761.462
8	7	166.658	298.803	6	3_2	99.708	562.266
9	8_1	211.310	401.944	7	6	136.854	566.270
12	9_1	256.915	281.703	8	7	165.412	300.076
13	10	265.465	753.521	9	8_1	210.052	403.198
14	11	299.218	464.186	12	9_1	255.652	282.978
15	12	299.111	721.358	13	10	264.174	754.781
16	14	320.703	277.858	14	11	297.939	465.433
17	13	335.785	781.525	15	12	297.819	722.635
19	15	355.251	200.553	16	14	319.461	279.126
20	43	356.819	174.339	17	13	334.502	782.780
22	42	358.927	716.154	19	15	354.027	201.843
23	17	399.339	662.360	20	43	355.576	175.617
25	18_1	424.167	485.825	21	16	355.221	493.901
27	19	443.070	801.664	22	42	357.682	717.380
29	20	488.600	338.922	23	17	398.091	663.630
30	49	497.943	———	25	18_1	422.896	487.133
31	48	532.223	603.305	—	73	423.798	777.883
32	41	532.332	779.179	27	19	441.783	802.989
33	21	536.119	710.083	29	20	487.351	340.219
35	23	592.581	749.822	30	49	496.717	665.593
36	22	597.393	719.373	31	48	530.973	604.571
37	40	604.206	804.443	32	41	531.084	———
—[1]	50	645.278	584.312	33	21	534.831	711.377
39	24	667.458	280.217	35	23	591.321	751.125
41	26	698.677	442.208	36	22	596.094	720.679
42	25	700.063	389.442	37	40	602.930	805.748
43	27	724.479	319.867	39	24	666.197	281.528
44	28	741.636	493.379	41	26	697.375	443.494
45	29	750.894	728.380	42	25	698.786	390.758
46	30	770.491	219.675	43	27	723.191	321.168
47	31	786.493	480.708	44	28	740.332	494.684
49	33	819.778	733.449	45	29	749.591	729.722
51	34	845.039	814.742	46	30	769.242	221.007
53	35	889.087	674.323	47	31	785.224	482.042
54	36	931.205	458.455	49	33	818.503	734.780
55	37	938.657	595.261	50	32	823.117	554.899
				51	34	843.752	816.058
61^1 Cygni		514.476	446.026	53	35	887.802	675.625
61^2 Cygni		521.288	441.061	54	36	929.927	459.790
				55	37	937.378	596.564
				61^1 Cygni		513.218	447.328
				61^2 Cygni		520.033	442.369

---

[1] B. D. +37° 4191.

TABLE II.—MEASURED COÖRDINATES (CORRECTED).—*Continued.*

Number in Catalog.	Number on Plate.	Plate π 515.	
		X	*Y*
8	7	166.096	Not measured
9	8_1	210.923	
15	12	298.761	
19	15	354.684	
23	17	398.992	
25	18_1	423.750	
29	20	488.161	
—	50	644.942	
39	24	666.992	
46	30	770.052	
47	31	786.146	
49	33	819.620	
55	37	938.400	
61^1 Cygni		524.976	
61^2 Cygni		531.777	

Number in Catalog.	Number on Plate.	Plate π 534.	
		X	*Y*
7	6	137.207	699.612
8	7	165.748	433.450
9	8_1	210.526	536.736
10	8_2	212.158	534.120
11	9_2	245.640	405.108
12	9_1	255.996	416.361
14	11	298.265	598.865
15	12	298.132	856.036
16	14	319.804	412.541
18	74	351.846	372.076
19	15	354.348	335.248
20	43	355.937	309.020
21	16	355.496	627.261
22	42	357.996	850.800
23	17	398.372	797.063
24	18_2	413.938	604.953
25	18_1	423.242	620.528
26	44	438.448	247.366
28	55	491.818	139.096
29	20	487.746	473.665
30	49	497.040	799.026
31	48	531.284	737.959
33	21	535.201	844.774
34	47	558.035	710.886
35	23	591.691	884.539
38	71	645.646	441.354
39	24	666.572	414.934
40	56	670.514	242.136
43	27	723.608	454.611
44	28	740.736	628.138
45	29	750.011	863.174
46	30	769.660	354.451
47	31	785.653	615.445
48	57	824.008	393.937
49	33	818.940	868.171
50	32	823.466	688.323
52	62	864.884	550.320
53	35	888.184	809.094
54	36	930.340	593.246
55	57	937.752	730.002
56	39	978.254	423.925
57	38	981.501	404.568
61^1 Cygni		524.562	589.585
61^2 Cygni		531.372	584.210

Number in Catalog.	Number on Plate.	Plate π 778.	
		X	*Y*
1	1	98.466	277.359
2	3_1	96.168	571.334
3	2	98.008	452.825
4	4_1	94.858	755.464
5	4_2	95.746	764.556
6	3_2	100.384	565.380
7	6	137.650	569.291
8	7	165.938	303.082
9	8_1	210.797	406.355
12	9_1	256.178	285.924
13	10	265.025	757.799
14	11	298.628	468.414
15	12	298.666	725.606
16	14	320.008	282.039
17	13	335.391	785.748
19	15	354.510	204.748
20	43	356.048	178.477
22	42	358.520	720.336
23	17	398.898	666.546
25	18_1	423.656	489.998
27	19	442.723	805.862
29	20	488.023	343.055
33	21	535.794	714.184
35	23	592.252	753.906
36	22	596.957	723.442
37	40	603.841	808.492
39	24	666.770	284.198
41	26	698.116	446.172
42	25	699.478	393.411

TABLE II.—MEASURED COÖRDINATES (CORRECTED).—*Continued.*

Number in Catalog.	Number on Plate.	Plate π 778.	
		X	*Y*
43	27	723.896	323.824
44	28	741.182	497.362
45	29	750.597	732.416
46	30	769.896	223.604
47	31	785.994	484.643
49	33	819.486	737.374
51	34	844.808	818.651
53	35	888.799	678.193
54	36	930.840	462.290
55	37	938.300	599.070
56	39	978.646	292.904
57	38	981.698	273.594
61^1 Cygni		526.035	459.812
61^2 Cygni		532.852	454.389
Plate π 785.			
8	7	165.572	Not measured
9	8_1	210.460	
15	12	298.410	
19	15	354.096	
23	17	398.634	
25	18_1	423.295	
29	20	487.638	
39	24	666.424	
46	30	769.508	
47	31	785.692	
49	33	819.258	
55	37	937.995	
61^1 Cygni		525.717	
61^2 Cygni		532.504	
Plate π 966.			
1	1	98.440	278.652
2	3_1	96.040	572.581
3	2	97.886	454.087
7	6	137.448	570.573
8	7	165.908	304.364
9	8_1	210.731	407.647
12	9_1	256.193	287.237
13	10	264.812	759.139
14	11	298.530	469.702
15	12	298.469	726.932
16	14	320.003	283.337
Number in Catalog.	Number on Plate.	Plate π 966.	
		X	*Y*
17	13	335.184	787.088
19	15	354.486	206.032
20	43	356.071	179.804
21	16	355.724	498.085
23	17	398.687	667.900
25	18_1	423.498	491.324
—	73	424.397	782.169
27	19	442.477	807.246
29	20	487.963	344.414
32	41	531.874	784.659
35	23	592.048	755.328
36	22	596.816	724.864
37	40	603.650	809.897
39	24	666.788	285.643
41	26	698.040	447.607
42	25	699.385	394.835
43	27	723.847	325.278
44	28	741.020	498.814
45	29	750.364	733.898
46	30	769.875	225.052
47	31	785.865	486.098
49	33	819.298	738.865
51	34	844.540	820.139
53	35	888.525	679.724
54	36	930.666	463.834
55	37	938.123	600.598
61^1 Cygni		526.345	461.600
61^2 Cygni		533.152	456.148
Plate π 982.			
1	1	98.212	273.503
2	3_1	95.774	567.426
3	2	97.630	448.944
4	4_1	94.355	751.541
5	4_2	95.236	760.640
6	3_2	99.944	561.452
7	6	137.168	565.419
8	7	165.617	299.273
9	8_1	210.428	402.537
10	8_2	212.120	399.934
11	9_2	245.500	270.895
12	9_1	255.893	282.133
13	10	264.465	753.986
14	11	298.195	464.626
15	12	298.119	721.785
16	14	319.682	278.265

TABLE II.—MEASURED COÖRDINATES (CORRECTED).—*Continued.*

Number in Catalog.	Number on Plate.	Plate π 982.		Number in Catalog.	Number on Plate.	Plate π 1263.	
		X	Y			X	Y
17	13	334.816	781.936	19	15	355.572	207.581
19	15	354.182	200.970	20	43	357.172	181.335
20	43	355.758	174.717	21	16	356.836	499.554
21	16	355.435	492.997	22	42	359.421	723.156
22	42	357.937	716.553	23	17	399.807	669.392
23	17	398.370	662.775	25	18_1	424.603	492.848
24	18_2	413.872	470.689	27	19	443.615	808.698
25	18_1	423.169	486.266	29	20	489.038	345.954
27	19	442.119	802.076	32	41	532.929	786.152
29	20	487.636	339.390	33	21	536.590	717.078
33	21	535.207	710.492	35	23	593.115	756.811
35	23	591.652	750.239	37	40	604.752	811.386
36	22	596.394	719.769	39	24	667.853	287.148
37	40	603.232	804.797	41	26	699.091	449.120
39	24	666.448	280.603	42	25	700.445	396.324
41	26	697.660	442.579	43	27	724.920	326.812
42	25	699.037	389.801	44	28	742.086	500.356
43	27	723.511	320.259	45	29	751.458	735.398
44	28	740.674	493.788	46	30	770.926	226.600
45	29	749.982	728.802	47	31	786.962	487.636
46	30	769.523	220.057	49	33	820.364	740.369
47	31	785.520	481.079	50	32	824.927	560.457
49	33	818.865	733.798	51	34	845.610	821.635
50	32	823.459	553.963	53	35	889.598	681.169
51	34	844.110	815.085	54	36	931.738	465.337
53	35	888.139	674.677	55	37	939.151	602.104
54	36	930.288	458.822	56	39	979.585	295.990
55	37	937.656	595.579	57	38	982.806	276.660
61^1 Cygni		526.070	456.554	61^1 Cygni		528.578	464.016
61^2 Cygni		532.890	451.097	61^2 Cygni		535.394	458.524
Plate π 1263.				Plate π 1270.			
1	1	99.588	280.163	1	1	98.640	293.978
2	3_1	97.127	574.087	2	3_1	96.240	587.978
3	2	99.015	455.616	3	2	98.126	469.471
4	4_1	95.790	758.224	4	4_1	94.899	772.059
5	4_2	96.674	767.346	7	6	137.675	585.934
7	6	138.576	572.088	8	7	166.124	319.722
8	7	167.004	305.887	9	8_1	210.952	423.054
9	8_1	211.816	409.188	12	9_1	256.370	302.607
12	9_1	257.253	288.746	13	10	265.066	774.426
13	10	265.935	760.586	14	11	298.712	485.076
14	11	299.618	471.248	15	12	298.674	742.281
15	12	299.576	728.428	16	14	320.194	298.746
16	14	321.092	284.900	17	13	335.395	802.394
17	13	336.311	788.577	19	15	354.661	221.452

TABLE II.—MEASURED COÖRDINATES (CORRECTED)—*Concluded.*

Number in Catalog.	Number on Plate.	Plate π 1270.		Number in Catalog.	Number on Plate.	Plate π 1270.	
		X	*Y*			*X*	*Y*
20	43	356.256	195.186	46	30	770.035	240.406
23	17	398.934	683.229	47	31	786.072	501.444
26	44	438.754	133.499	49	33	819.495	754.168
27	19	442.663	822.549	50	32	824.020	574.264
29	20	488.146	359.785	51	34	844.722	835.428
32	41	532.020	799.954	53	35	888.658	695.040
35	23	592.212	770.620	54	36	930.838	479.173
36	22	597.002	740.130	55	37	938.286	615.902
37	40	603.850	825.222	56	39	978.680	309.834
39	24	666.946	300.988	57	38	981.944	290.476
41	26	698.192	462.950				
43	27	724.030	340.608	61¹ Cygni		527.704	477.870
45	29	750.549	749.167	61² Cygni		534.508	472.340

II. PROPER MOTIONS.

1. **Relations Between the Plates.**—In addition to the accidental errors of measurement, there are two groups of causes which effect a difference in the position of the images of the same star on any two plates. The first group includes refraction, aberration, precession and nutation which alter the apparent right ascension and declination of the star in the sky. The second group includes the unavoidable errors of the plates themselves due to differences of centering, of orientation and of scale value.

The errors of the first group may be considered from the theoretical point of view, separately calculated,[1] and applied to the measure. The errors of the second group can only be derived empirically for each plate from the measures themselves. If the measures have been corrected for the errors of the first group, the true coördinates of a given star may be expressed as:

$$X + aX + bY + c \cdots \text{ for the } X \text{ direction,}$$
$$Y + dX + eY + f \cdots \text{ for the } Y \text{ direction,}$$

where X and Y are the measured coördinates, and

$$\text{for}\begin{cases} X \cdots a = \text{scale}, & b = \text{orientation}, \quad c = \text{zero, constant}, \\ Y \cdots e = \text{scale}, & d = \text{orientation}, \quad f = \text{zero, constant}. \end{cases}$$

If for any stars on the plate the coördinates X' and Y' from some standard plate are known, each such star gives two equations of the forms:

$$X + aX + bY + c = X',$$
$$Y + dX + eY + f = Y'.$$

Three or more stars make possible, therefore, the determination of a, b, c, d, e and f which may then be used to correct the measured coördinates of all the other stars on the plate.

---

[1] Rayet, *Annales de l'Obs. de Bordeaux*, Vol. IX, p. 64 et seq.; Zurhellen, Darlegung und Kritik der zur Reduction photographischer Himmelsaufnahmen aufgestellten Formeln und Methoden, pp. 7–70.

Turner[1] was the first to show, however, that this procedure is unnecessarily laborious since, except for the photographs taken at great zenith distances, all the sensible terms of the errors of the first group are linear also and may be included in equations of the form above.

Using these relations the determinations of proper motion and parallax in the following pages have been carried out by an intercomparison of the plates themselves without any reference to the catalog positions of any of the stars.

2. **Derivation of Proper Motions.**—The study including all the stars on the two early plates compared with one or more of the plates of later date, thus giving an interval of eight or nine years, has shown only one star, No. 9, to have a proper motion large enough to be derived from these measures. Even this proper motion is small, approximately $+0''.04$ a year in the direction of the X coördinate and $+0''.05$ a year in the direction of the Y coördinate. The parallax[2] of this star is found to be $+0''.006 \pm .018$, *i. e.*, it has no sensible parallactic displacement on these plates.

Two mean plates were formed, the first from plates 414 and 415, the second from π1263 and π1270, using thirty stars common to the four plates. The most probable values of the plate constants derived from the least squares solution of the thirty equations are:

X Direction.	Y Direction.
$a = +.000114$,	$e = +.000178$,
$b = +.000329$,	$d = -.000400$,
$c = +0.4064$ turns,	$f = -0.6203$ turns.

These values were applied to the measures in the sense of reducing the mean of the two early plates to the mean of the two late plates. That is, if X and Y are the mean coördinates from 414 and 415 for a star, and X' and Y' the mean coördinates from π1263 and π1270 for the same star, the residuals of the following equations are due to the sum of the accidental errors and the proper motions.

---

[1] *Monthly Notices of the Royal Astronomical Society*, Vol. LIV, p. 11 et seq.

[2] See p. 22.

$$(X - X') + aX + bY + c = v_x,$$
$$(Y - Y') + dX + eY + f = v_y.$$

Star 9[1] shows in both directions a residual more than double that of the largest among the remaining 29.

Peirce's criterion[2] for rejecting doubtful observations was applied. No other star shows a residual larger than was to be expected as the result of purely accidental errors.

To test other stars found on either 414 or 415 for possible proper motions, π966 was used as the standard system to which to reduce the positions of stars on the two earliest and two latest plates. The following plate constants were determined from 18 stars common to all the plates and well distributed. The least squares solutions of the 18 equations give:

		414	415	π1263	π1270
X direction	*a* ···	+ .000191	+ .000219	+ .000062	+ .000067
	b ···	+ .000229	+ .000276	− .000053	− .000044
	c ···	−0.6238 turns	+0.6423 turns	−1.0803 turns	−0.1852 turns
Y direction	*d* ···	− .000274	− .000355	+ .000010	+ .000059
	e ···	+ .000135	+ .000145	+ .000107	+ .000116
	f ···	+5.4688 turns	+4.1686 turns	−1.5131 turns	−15.3406 turns

Plate 415 was also compared with π982, reducing the early to the late as a standard by use of the following constants, determined by a least squares solution of 40 stars.

X Direction	*Y* Direction
$a = +.000191$,	$e = -.000015$,
$b = +.000306$,	$d = -.000201$,
$c = +0.0143$ turns,	$f = -7.7780$ turns.

Three stars on the early plates, 31, 30, and a star numbered 73 on the plates, were investigated as follows. Stars 31 and 30 were reduced to the standard system of plate π966 from their measured positions on π534 by means of plate constants found from 8 stars in the course of the parallax work and were then compared with the positions from 415 similarly reduced. Star with plate number 73 was found only on 414 and π966 and was compared by reducing the position on 414 to the standard system, as above.

---

[1] See Table III, p. 14.

[2] Chauvenet, Spherical and Practical Astronomy, Vol. II, p. 558 et seq.

The proper motion study has thus included 45 stars near 61 Cygni, only one star showing a significant residual. Assuming, however, that the residuals resulting from the several comparisons specified are due to proper motion only—certainly an untrue assumption—each residual has been divided by the interval in years and tenths between the plates compared, and Table III has been constructed.

It may be noticed that even without applying Peirce's criterion, star 9 stands out as having a determined proper motion, the other residuals appearing quite accidental in character.

3. **Proper Motion of 61 Cygni.**—Assuming the proper motion of each of the components of 61 Cygni to be uniform, from Table III, the annual amount is found to be

$$\left.\begin{array}{l}+4''.09 \text{ in the } X \text{ direction}\\ +3''.29 \text{ in the } Y \text{ direction}\end{array}\right\}\text{for } 61^1 \text{ Cygni,}$$

$$\left.\begin{array}{l}+4''.09 \text{ in the } X \text{ direction}\\ +3''.12 \text{ in the } Y \text{ direction}\end{array}\right\}\text{for } 61^2 \text{ Cygni,}$$

during the period from August 1904 to June 1913. The results from the parallax equations[1] are nearly identical:

$$\left.\begin{array}{l}+4''.08 \text{ in the } X \text{ direction for } 61^1 \text{ Cygni}\\ +4''.09 \text{ in the } X \text{ direction for } 61^2 \text{ Cygni}\end{array}\right\}\text{annually}$$

during the period from October 1911 to June 1913.

No variation in the proper motion of 61^1 Cygni can be detected from these measures. All the variations in the residuals from the equations formed in the parallax determinations have been found to be less than the probable errors.

---

[1] See pp. 21, 22.

TABLE III.—PROPER MOTIONS (ANNUAL).

Star.		Unit = 1″.											
		Residuals, X Direction. Comparison of						Residuals, Y Direction. Comparison of					
Catalog Number.	Plate Number.	Mean of 414 and 415. Mean of 1263 and 1270.	415 π982.	414 π1263.	414 π1270.	415 π1263.	415 π1270.	Mean of 414 and 415. Mean of 1263 and 1270.	415 π982.	414 π1263.	414 π1270.	415 π1263.	415 π1270.
1	1	+ .001	+ .036	+ .008	− .010	+ .009	− .008	+ .016	+ .001	+ .022	+ .008	+ .016	+ .004
2	3_1	− .005	+ .037	− .008	− .007	− .017	− .001	− .002	− .001	.000	+ .014	− .004	+ .011
3	2	− .019	+ .007	− .021	− .019	.000	− .016	− .004	− .011	− .001	+ .022	− .010	+ .011
4	4_1	− .021	− .007	− .019	− .018	− .017	− .016	− .012	− .003	+ .003	− .010	− .009	− .023
5	4_2	—	− .003	—	—	− .014	—	—	− .004	—	—	− .005	—
6	3_2	—	+ .010	—	—	—	—	—	− .002	—	—	—	—
7	6	+ .013	+ .008	+ .012	+ .016	+ .009	+ .008	+ .013	− .012	− .003	− .012	+ .023	+ .021
8	7	+ .001	+ .022	− .001	+ .002	− .001	+ .002	− .001	+ .004	− .002	− .007	− .004	− .008
9	8_1	+ .042	+ .063	+ .036	+ .032	+ .038	+ .040	+ .055	+ .048	+ .037	+ .054	+ .054	+ .061
12	9_1	.000	+ .029	− .006	− .003	− .001	+ .001	+ .003	− .002	− .007	− .002	− .006	+ .001
13	10	− .001	− .001	− .006	+ .001	.000	+ .008	− .016	+ .018	− .004	− .004	.000	.000
14	11	− .002	+ .013	− .003	− .008	− .014	− .001	+ .003	+ .012	+ .001	− .003	+ .001	+ .006
15	12	− .005	+ .003	− .007	− .008	+ .002	.000	− .010	− .001	+ .001	+ .006	+ .018	+ .005
16	14	+ .008	+ .013	− .008	+ .006	+ .006	+ .003	+ .010	− .006	− .001	.000	+ .003	+ .004
17	13	+ .006	− .001	+ .008	− .001	+ .008	+ .002	− .021	+ .004	− .002	− .008	+ .006	.000
19	15	− .011	+ .003	− .008	+ .020	− .015	+ .013	+ .013	+ .007	− .002	+ .005	− .003	+ .006
20	43	+ .003	+ .014	− .004	− .004	− .002	− .004	+ .005	− .016	− .012	− .009	− .009	− .007
21	16	—	− .006	—	—	− .022	—	—	− .029	—	—	− .032	—
22	42	—	− .015	− .001	—	− .008	—	—	+ .010	− .022	—	− .006	—
23	17	− .004	− .004	− .004	+ .002	− .018	− .005	− .008	+ .004	− .001	.000	+ .003	+ .004
25	18_1	—	+ .009	.000	—	+ .002	—	—	+ .001	.000	—	− .006	—
27	19	− .002	− .003	+ .005	− .011	+ .008	− .008	− .010	− .012	+ .002	+ .008	− .010	− .004
29	20	+ .013	+ .024	+ .010	+ .011	+ .008	+ .008	+ .017	+ .016	+ .009	+ .022	+ .008	+ .021
32	41	—	—	+ .019	+ .017	− .008	+ .005	—	—	− .006	− .016	—	—

TABLE III.—PROPER MOTIONS (ANNUAL).—*Concluded.*

Unit = 1″.

Star.		Residuals, *X* Direction. Comparison of						Residuals, *Y* Direction. Comparison of					
Catalog Number.	Plate Number.	Mean of 414 and 415. Mean of 1263 and 1270.	415 π982.	414 π1263.	414 π1270.	415 π1263.	415 π1270.	Mean of 414 and 415. Mean of 1263 and 1270.	415 π982.	414 π1263.	414 π1270.	415 π1263.	415 π1270.
33	21	—	− .014	+ .017	—	− .010	—	—	+ .003	− .006	—	− .009	—
35	23	− .002	− .008	+ .001	− .002	− .005	− .007	− .010	+ .006	.000	− .003	− .001	− .004
36	22	—	− .016	—	− .006	—	+ .001	—	− .001	—	− .014	—	− .016
37	40	− .002	+ .024	− .001	− .002	− .002	− .004	− .022	− .013	− .012	− .013	− .011	− .011
39	24	− .001	+ .008	− .004	− .009	− .004	− .008	+ .010	− .003	− .006	− .001	− .007	− .001
41	26	− .002	+ .001	− .014	− .015	− .003	− .005	− .008	+ .003	− .010	− .008	− .003	.000
42	25	—	− .005	− .022	—	− .015	—	—	− .011	− .018	—	− .019	—
43	27	+ .020	+ .023	+ .004	+ .006	+ .008	+ .014	+ .017	+ .006	+ .014	− .004	+ .018	− .001
44	28	—	+ .011	+ .001	—	− .002	—	—	+ .012	+ .013	—	+ .016	—
45	29	+ .010	+ .004	+ .006	+ .001	+ .012	+ .008	+ .007	+ .006	+ .024	+ .010	+ .017	+ .001
46	30	+ .015	+ .017	+ .009	+ .007	+ .007	+ .007	+ .017	+ .006	+ .015	− .002	+ .011	− .006
47	31	+ .002	− .005	− .005	− .002	− .006	− .003	+ .005	− .007	+ .002	− .003	− .003	− .008
49	33	+ .015	− .010	+ .009	+ .018	+ .006	+ .015	− .004	+ .010	.000	− .004	+ .003	− .008
50	32	—	+ .003	—	—	+ .008	+ .006	—	− .005	—	—	− .014	− .014
51	34	.000	− .022	+ .004	.000	− .004	− .001	− .017	+ .005	− .006	− .012	− .005	− .011
53	35	− .014	− .017	− .011	− .024	− .017	− .026	− .005	+ .005	− .017	+ .003	− .008	+ .010
54	36	+ .018	+ .019	+ .011	+ .010	+ .012	+ .011	+ .013	+ .001	+ .001	+ .009	.000	− .022
55	37	− .003	− .031	− .011	− .005	− .009	− .003	− .007	− .004	− .011	− .015	− .004	− .008
61¹ Cygni		+4.099	+4.096	+4.090	+4.092	+4.091	+4.098	+3.298	+3.256	+3.294	+3.301	+3.292	+3.299
61² Cygni		+4.097	+4.098	+4.093	+4.089	+4.092	+4.095	+3.134	+3.096	+3.109	+3.125	+3.134	+3.129
		Residuals, *X* Direction.						Residuals, *Y* Direction.					
30	49	From plate 415 and π534.......... −.005						+.011					
31	48	From plate 415 and π534.......... −.001						+.010					
—	73	From plate 414 and π966.......... +.027						+.008					

III. PARALLAX.

On account of the orbital motion of the earth, a star with measurable parallax appears to shift its position in reference to a fixed point among the stars, tracing an elliptical path each year. In the present discussion the parallaxes have been determined by an intercomparison of the plates from the changes in the X coördinate caused by the star's motion in this path; *i. e.*, approximately the changes in right ascension.

1. **Parallax Factor.**—The parallax factor in right ascension for any date depends only on the star's right ascension and the sun's longitude. If we call the semi-major axis of the parallactic ellipse unity, the parallax factor in right ascension at its maximum is 1 for a star whose right ascension is 6^h or 18^h but only 0.92 for a star whose right ascension is 0^h or 12^h. For the region under consideration the maximum is 0.95, approximately, and is attained about May 7 and November 8. A comparison of these dates with Table I shows that the 8 plates used for parallax determinations were taken near the time of maximum parallax factor in right ascension. The total available displacement in right ascension is 1.746.[1] The parallax factors for declination were also calculated but, as the total available displacement was small, no reduction for parallax from the declinations has been made. The parallax factors in right ascension have been calculated by two equivalent formulæ, I and II below, in order to check the numerical work completely. A third convenient form is also given.

I.[2] $$P = Rm \sin(\odot - M).$$

II.[3] $$P = R \cos D \sin(A - \alpha),$$

where P = parallax factor in right ascension,
R = radius vector of the earth,
$\odot$ = longitude of the sun,

---

[1] Table IV C, p. 21.

[2] Chauvenet, Vol. I, p. 633, 645. Publications of the Astronomical Laboratory at Groningen, J. C. Kapteyn, No. 1, p. 56.

[3] Andre, *Traité D'Astronomie Stellaire*, Vol. I, pp. 248, 249.

A = right ascension of the sun,
α = right ascension of the star,
D = declination of the sun,
ϵ = obliquity of the ecliptic,

$$\tan M = \frac{\tan \alpha}{\cos \epsilon},$$

$$m = \frac{\sin \alpha}{\sin M}.$$

III.[1] $$P = R[\sin (\odot - \alpha) + c],$$
$$\text{where } c = -2 \sin^2 \tfrac{1}{2}\epsilon \sin \odot \cos \alpha.$$

The point used as the fixed point among the stars and therefore as the origin of coördinates is the mean position of the comparison stars.

In considering only the displacement in right ascension it is necessary, by the ordinary procedure, to find the plate constants a, b, c,[2] by a least squares solution from the comparison stars, using any plate, one in the middle of the series is most convenient, as a standard. Plate π966 was chosen as a standard. The constants a, b, c, may be determined more quickly and without loss of precision in the results by Dyson's[3] method of grouping the equations and this method was employed by the writer.

2. Two Methods of Finding the Solution of Plates.—The observed quantity $(-m)$ for each plate is

$$(X_\pi' - X_\pi) + aX_\pi' + bY_\pi' + c,$$

where X_π refers to the parallax star on the plate in question, X_π' and Y_π', on the standard plate. It is evident from this expression that any errors in the determination of the plate constants affect the result directly proportional to the absolute value of X_π' and Y_π'. The comparison stars were, therefore, so chosen that their centroid, the origin of coördinates, was as near as possible to the position of the parallax star.

---

[1] Groningen Pub., No. 15, p. 12; a table for c is given.

[2] See p. 10.

[3] *Monthly Notices*, Vol. LV, p. 61 and Vol. LVI, p. 118, 119. Also, Determinations of Stellar Parallax, Carnegie Institution, H. N. Russell, p. 22, et seq.

Schlesinger[1] has published a shorter method for finding the solutions of the plates, deriving what he terms the *dependences* for the comparison stars. Besides lessening the work these dependences are an exact measure of the relative importance of the comparison stars. The comparison stars should be distributed over the plate so that their dependences are nearly equal. The notation and equations used in deriving these dependences are easily understood and the following equations are given in nearly the form in which they appear in the original paper.

Primes refer to values on the standard plate,
numeral subscripts to the several comparison stars,
π subscripts to the parallax star.

Form of observation equations:

$$
(1) \qquad \left\{ \begin{array}{l} aX_1' + bY_1' + c + (X_1 - X_1') = v_1, \\ aX_2' + bY_2' + c + (X_2 - X_2') = v_2, \\ \qquad\qquad \text{etc.} \end{array} \right.
$$

Subtract a constant from the coördinates on the standard plate so that $[X']$ and $[Y'] = 0$. Then from the solution of the normal equations,

$$
(2) \qquad \left\{ \begin{array}{l} a = \dfrac{[Y'(X - X')][X'Y'] - [X'(X - X')][Y'^2]}{[X'^2][Y'^2] - [X'Y']^2} \\ \qquad\qquad = 1 - \dfrac{[X'X][Y'^2] - [XY'][X'Y']}{[X'^2][Y'^2] - [X'Y']^2}, \\ b = \dfrac{[X'(X - X')][X'Y'] - [Y'(X - X')][X'^2]}{[X'^2][Y'^2] - [X'Y']^2} \\ \qquad\qquad = \dfrac{[X'X][X'Y'] - [XY'][X'^2]}{[X'^2][Y'^2] - [X'Y']^2}. \\ c = -\dfrac{1}{n}[X]. \end{array} \right.
$$

For any plate

$$
(3) \qquad m = \text{solution} = X_\pi + aX_\pi' + bY_\pi' + c.
$$

Substitute the values from (2) in (3).

---

[1] Photo. Determ., p. 37, et seq.

$$
\begin{aligned}
(4)\ m = {} & X_\pi + X_\pi' \\
& -X_1\left\{\frac{X_1'(X_\pi'[Y'^2]) - Y_1'(X_\pi'[X'Y']) + Y_1'(Y_\pi'[X'^2]) - X_1'(Y_\pi'[X'Y'])}{[X'^2][Y'^2] - [X'Y']^2} + \frac{1}{n}\right\} \\
& -X_2\left\{\frac{X_2'(X_\pi'[Y'^2]) - Y_2'(X_\pi'[X'Y']) + Y_2'(Y_\pi'[X'^2]) - X_2'(Y_\pi'[X'Y'])}{[X'^2][Y'^2] - [X'Y']^2} + \frac{1}{n}\right\} \\
& -X_3\{\text{etc.}
\end{aligned}
$$

Quantities in parentheses are the same for all comparison stars. Quantities in curved brackets are the same for all plates, and are called *dependences;* symbols D_1, D_2, D_3, etc.

$$[D] = 1.$$

When comparing m from the several plates add a constant, X_π', to each. Then for any plate,

$$m = X_\pi - [D \cdot X].$$

When m has been found by either method, if

P = the parallax factor,

T = 1/100 of the time, in days, between the standard plate and the plate in question,

π = annual parallax,

μ = proper motion in 100 days,

then each plate gives an equation of the form

$$P\pi + T\mu + c = m, \quad \text{weight } p.$$

All the plates used had two images of each star and appeared to be of nearly the same degree of excellence, so unit weight was assigned throughout.

The writer found the solution of the plates, m, for both components of 61 Cygni by both the method of plate constants and of dependences. For star 9, the dependence method alone was used. The 8 observation equations, in the case of star 9 only 6 equations, were solved to find the parallax, π, and incidentally μ and c, by the method of least squares.

The annual parallax so determined is relative parallax only. To find the absolute parallax there should be subtracted from it a quantity equal to the sum of terms found by multiplying the parallax of each comparison star by its dependence.

For 61^1 and 61^2 Cygni a preliminary determination of the parallax was made with only 4 comparison stars, a second with 8 comparison stars. In the set of 8 comparison stars, No. 9[1] was used. As its parallax is inappreciable it cannot affect the resulting values of the parallax of the components of 61 Cygni. Its proper motion does certainly alter the value of the proper motion derived for the components of 61 Cygni. In the short interval covered by the parallax plates and considering, by the use of its dependence, the effect this star could have on the resulting proper motions, the amount by which it can alter the resulting proper motion of 61 Cygni is less than 0″.01.

The following tabular representation gives the essentials of the solution. The magnitudes of the comparison stars may be found in the catalog, pp. 33 et seq.

TABLE IV.—PARALLAXES.

Unless otherwise stated the unit = 1 turn of the micrometer screw = 2″.66

A. FIRST GROUP OF COMPARISON STARS FOR 61^1 AND 61^2 CYGNI.

Catalog Number.	Plate Number.	X	Y	Dependence for 61^1 Cygni.	Dependence for 61^2 Cygni.
15	12	−236.291	+237.564	0.228	0.211
19	15	−180.274	−283.336	.286	.286
39	24	+132.028	−203.725	.270	.282
49	33	+284.538	+249.497	.216	.221
61^1 Cygni		− 8.415	− 27.768	[*D*] 1.000	[*D*] 1.000
61^2 Cygni		− 1.608	− 33.220		

B. SECOND GROUP OF COMPARISON STARS FOR 61^1 AND 61^2 CYGNI.

Catalog Number.	Plate Number.	X	Y	Dependence for 61^1 Cygni.	Dependence for 61^2 Cygni.
8	7	−363.398	−158.665	0.128	0.124
9	8	−318.575	− 55.382	.127	.124
15	12	−230.837	+263.903	.125	.123
23	17	−130.619	+204.871	.124	.124
39	24	+137.482	−177.386	.125	.126
46	30	+240.569	−237.977	.125	.127
47	31	+256.559	+ 23.069	.124	.126
55	37	+408.817	+137.569	.122	.126
61^1 Cygni		− 2.961	− 1.429	[*D*] 1.000	[*D*] 1.000
61^2 Cygni		+ 3.846	− 6.881		

---

[1] See p. 13.

C. REDUCTIONS FOR 61^1 AND 61^2 CYGNI.

late.	P	T	Solution.				Residuals.			
			Group *A.*		Group *B.*		Group *A.*		Group *B.*	
			61^1	61^2	61^1	61^2	61^1	61^2	61^1	61^2
515	−.833	−3.86	−1.617	−1.624	−1.609	−1.614	+.011	+.016	+.008	+.008
534	−.941	−3.65	−1.532	−1.531	−1.532	−1.526	+.002	+.001	+.001	−.003
778	+.799	−1.41	−0.397	−0.386	−0.411	−0.401	−.009	−.019	−.003	−.019
785	+.789	−1.40	−0.396	−0.404	−0.408	−0.428	−.007	+.002	−.003	+.011
966	−.940	0.00	0.000	0.000	0.000	0.000	+.003	+.008	+.006	+.012
982	−.947	+0.13	+0.077	+0.088	+0.075	+0.083	−.019	−.025	−.015	−.017
1263	+.664	+2.37	+1.152	+1.160	+1.151	+1.162	+.017	+.014	+.005	.000
1270	+.653	+2.38	+1.169	+1.173	+1.159	+1.160	+.002	+.004	.000	+.005
							$[v]$ = .000	$[v]$ = +.001	$[v]$ = −.001	$[v]$ = −.003

NORMAL EQUATIONS AND THEIR SOLUTIONS.

Group A. 61^1 Cygni.

$$\begin{aligned}5.488\pi + 7.423\mu - 0.756c &= +\ 3.615,\\ +43.468\quad -5.440 &= +18.447,\\ +8.000 &= -\ 1.544;\end{aligned}$$

$\therefore\ c = +0.102$,

$\mu = +0.4197 = +1''.116 \pm ''.004$, Annual proper motion in $X = 4''.073$.

$\pi = +0.1047 = +0''.267 \pm ''.011$.

Probable error corresponding to unit weight = ±.0085 = ±″.021.

61^2 Cygni.

$$\begin{aligned}5.488\pi + 7.423\mu - 0.756c &= +\ 3.620,\\ +43.468\quad -5.440 &= +18.518,\\ +8.000 &= -\ 1.524;\end{aligned}$$

$\therefore\ c = +0.106$,

$\mu = +0.4215 = +1''.121 \pm ''.005$, Annual proper motion in $X = 4''.092$.

$\pi = +0.1041 = +0''.277 \pm ''.012$.

Probable error corresponding to unit weight = ±.0095 = ±″.025.

Group B. 61^1 Cygni.

$$\begin{aligned}5.488\pi + 7.423\mu - 0.756c &= +\ 3.574,\\ +43.468\quad -5.440 &= +18.449,\\ +8.000 &= -\ 1.565;\end{aligned}$$

$\therefore\ c = +0.099$,

$\mu = +0.4204 = +1''.118 \pm ''.003$, Annual proper motion in $X = 4''.081$.

$\pi = +0.0963 = +0''.256 \pm ''.007$.

Probable error corresponding to unit weight = ±.0058 = ±″.015.

61^2 Cygni.

$$\begin{aligned} 5.488\pi + 7.423\mu - 0.756c &= +\ 3.572, \\ +43.468\quad - 5.440 &= +18.490, \\ +8.000 &= -\ 1.564; \end{aligned}$$

$\therefore\ c = +0.100,$

$\mu = +0.4219 = +1''.122 \pm''.005$, Annual proper motion in $X = 4''.095$.

$\pi = +0.0941 = +0''.251 \pm''.012.$

Probable error corresponding to unit weight = $\pm.0096 = \pm''.025$.

D. COMPARISON STARS FOR STAR 9.

Catalog Number.	Plate Number.	*X*	*Y*	Dependence.
8	7	−48.612	−103.605	0.265
7	6	−77.072	+162.604	.262
12	9	+41.673	−120.732	.245
14	11	+84.010	+ 61.733	.228
9	8_1	− 3.789	− 0.322	[*D*] 1.000

E. REDUCTION FOR STAR 9.

Plate.	*P*	*T*	Solution.	Residuals.
π534	−.942	−3.65	+.009	−.008
π778	+.796	−1.41	−.014	+.016
π966	−.941	0.00	.000	−.004
π982	−.947	+0.13	−.023	+.019
π1263	+.660	+2.37	−.009	+.009
π1270	+.649	+2.38	−.019	−.020
				[*v*] = +.012

NORMAL EQUATIONS AND THEIR SOLUTIONS.

$$\begin{aligned} 6.000c - 0.418\mu - 0.725\pi &= -0.476, \\ +0.155\quad +0.269 &= +0.032, \\ +4.160 &= +0.066; \end{aligned}$$

$\therefore\ c = +0.021,$

$\mu = -0.0137 = -0''.004 \pm''.106,$

$\pi = +0.0024 = +0''.006 \pm''.018.$

Probable error corresponding to unit weight = $\pm0.0134 = \pm''.036$.

IV. CATALOG.

1. **Analysis of Procedure.**—The formation of a catalog of the positions of the stars involves three distinct steps. First, the right ascensions and declinations of all the stars whose positions, as determined by meridian observations, are given in catalogs, must be transformed to give *ideal* rectangular coördinates. Ideal coördinates are those which may be supposed to be found on a fictitious plate free from the effects of aberration and refraction, with its zero point correctly determined and its coördinate axes correctly oriented in reference to the mean equinox and equator chosen for the catalog.

Second, the ideal coördinates being found, the measured coördinates of the stars on each plate must be reduced by means of derived plate constants to the system of the fictitious, ideal plate.

The third step is the reverse of the first; *i. e.*, the ideal X and Y coördinates for each star on each plate must be transformed into right ascensions and declinations.

2. **Right Ascensions and Declinations Transformed to Ideal Coördinates.**—To change right ascensions and declinations into ideal coördinates, a knowledge of the right ascension and declination of some central point of the region photographed is assumed. The difference between this and the given right ascension and declination for the fiducial stars, both expressed in seconds of arc, may be considered as the coördinates of the stars on the sphere. These coördinates are supposed to be projected from the center of the sphere on a plate which is tangent to the sphere precisely at the chosen central point. It is required to find the corresponding rectangular coördinates on the plate.

The problem may be solved by the use either of complete trigonometrical formulæ such as those given by Turner,[1]

---

[1] *Monthly Notices*, Vol. LIV, pp. 13, 17, 18.

Trepied[1] and many others, or by a series development as given by Jacoby.[2]

The only basis of choice[3] between the two procedures is economy of time for the work in question. In the present computation both methods were employed to secure an effectual check on the numerical work. The trigonometrical formulæ were used in the following form:[4]

ξ, η = ideal coördinates of the star,
α, δ = catalog right ascension and declination of the star,
A, D = right ascension and declination of center of plate,

$$\begin{aligned} \tan q &= \tan \delta \sec (\alpha - A), \\ \xi &= \tan (\alpha - \mathrm{A}) \cos q \sec (q - D), \\ \eta &= \tan (q - D). \end{aligned}$$

The series were used in the following form:

$\Delta\alpha$ = difference in right ascension between center and star expressed in seconds of time,
$\Delta\delta$ = difference in declination between center and star expressed in seconds of arc,
δ = declination of plate center,
X', Y' = ideal coördinates,

$$\begin{aligned} X' \sec \delta &= \Delta\alpha + A_1'\Delta\alpha\Delta\delta & A_1' &= -\operatorname{tang} \delta \sin 1'', \\ &\quad + A_2'\Delta\alpha^3 & A_2' &= \tfrac{1}{3}(1 - \tfrac{3}{2}\sin^2 \delta)(15)^2 \sin^2 1'', \\ &\quad \cdot \quad \cdot \quad \cdot \quad \cdot, & & \\ Y' &= \Delta\delta + D_1'\Delta\alpha^2 & D_1' &= \tfrac{1}{4}\sin 2\delta(15)^2 \sin 1'', \\ &\quad + D_2'\Delta\alpha^2\Delta\delta & D_2' &= \tfrac{1}{2}\cos 2\delta(15)^2 \sin^2 1'', \\ &\quad + D_3'\Delta\delta^3 & D_3' &= \tfrac{1}{3}\sin^2 1''. \\ &\quad \cdot \quad \cdot \quad \cdot \quad \cdot, & & \end{aligned}$$

Terms of the fourth and higher orders were always negligible.

3. **Plate Constants, to Transform Measured Coördinates to Ideal.**—The *central point* chosen was the point having a

---

[1] Introduction to Algeirs section Astrographic Catalog and *Monthly Notices*, Vol. LXIV, p. 647 (Dyson).

[2] *Bulletin du Comité International Permanent pour l'exécution Photographique de la Carte du Ciel*, Tome III, and *Vierteljahrsschrift der Astronomische Gesellschaft*, Vol. 30, p. 114, and *Contributions from the Observatory of Columbia University*, No. 23, p. 6.

[3] Zurhellen, Himmelsaufnahmen, p. 85, et seq.

[4] *Monthly Notices*, Vol. LX, p. 427, Turner.

right ascension equal to the mean of the right ascension of 61^1 and of 61^2 Cygni and a declination equal to the mean of their declinations. The coördinates of this point were used as derived from the positions and proper motions of 61^1 and 61^2 Cygni given by Boss,[1] by the formulæ

$$\text{R. A.}_{1900} + \mu_\alpha t + \frac{100\Delta\mu_\alpha}{200} t^2 = \text{R. A.}_{(1900+t)},$$

$$\text{Decl.}_{1900} + \mu_\delta t + \frac{100\Delta\mu_\delta}{200} t^2 = \text{Decl.}_{(1900+t)}.$$

COÖRDINATES OF THE CENTRAL POINT.

Plate.	π534.	π778.	π1263.	π1270.
R. A. Decl.	$21^h\,2^m\,29^s.782$ 38° 15′ 57″.75	$21^h\,2^m\,29^s.998$ 38° 15′ 59″.68	$21^h\,2^m\,30^s.361$ 38° 16′ 2″.94	$21^h\,2^m\,30^s.362$ 38° 16′ 2″.96

The debated question as to the use of four or six plate constants is easily settled in this particular case. Where the four constant method is used the corrections for refraction are calculated[2] and applied to the measures. It is then assumed (*a*) that the scale value is the same in the two directions and (*b*) that the measures have been made precisely at right angles, or if this latter condition is not fulfilled that the rotation correction[3] is known and has been applied to the measures.

The corrections for the two coördinates may then be expressed in the following form:

$$\begin{aligned} \text{for } X,\quad & pX + rY + k, \\ Y,\quad & pY - rX + c. \end{aligned}$$

A very concise form of rigorous solution for equations arising in this way has been given by Jacoby.[4]

The assumption (*b*), above, is not possible in the reduction of this series of plates. The turning of the plate[1] in the measuring machine was not accomplished by means of a graduated circle but by small dots cut in four steel posts fastened to the rim of the circular frame holding the plate. The upper surfaces of these posts are in the same plane as the film of the plate and the dots are so adjusted that the line joining the first and third is nearly perpendicular to the line joining the second and fourth. The amount by which this fails to be true can be determined and was so determined by the writer in the summer of 1912. The deviation was found to be too small to cause appreciable errors in the work on parallax then in hand. In 1913, when the measures for this paper were made, there was no thought of using them for a catalog of positions, therefore the question of the advisability of redetermining this deviation did not arise and no measures on the posts were recorded.

---

[1] Preliminary General Catalog of 6188 stars for the epoch 1900.

[2] *Astronomical Journal*, Vol. XV, p. 108, No. 350 and Vol. XVII, p. 22, No. 387, Jacoby; *Contrib. Obs. Col. Univ.*, No. 15, p. 285, Schlesinger, and Handwörterbuch der Astronomie, Valentiner., Vol. I, p. 287, etc.

[3] *Contrib. Obs. Col. Univ.*, No. 24, pp. 11, 12, Young.

[4] *Monthly Notices*, Vol. LVI, p. 424.

Since it is not possible to assume in this case that if $+r$ is the orientation constant in X, $-r$ is the orientation constant in Y, the 6 constant method has been used, determining the 3 constants for the X direction, and the 3 for the Y direction, independently.

It was first shown by Rambaut[2] that for plates such as these the appreciable refraction terms are linear. Aberration[3] alters distances between stars by a constant factor and changes position angles equally in all directions. Precession and nutation change the orientation of the axes of reference themselves. These corrections may, therefore, be included in the scale and orientation corrections.

Two[4] causes enter to displace the zero point from its assumed position. First, the right ascension and declination of this point may not be correctly known. This introduces a constant linear correction. Second,[5] the zero point may also be displaced by the circumstance that the plate is not set in the telescope so as to be perpendicular to the line joining the central point of the plate with the optical center of the object glass. This introduces terms of the forms, $X^2 \sin \gamma$, $Y^2 \cos \gamma$, $XY \cos \gamma$, $XY \sin \gamma$, where γ equals the angle of tilt.

---

[1] Photo. Determ., Schlesinger, p. 21.

[2] *Astronomische Nachrichten*, Bd. 131, No. 3125, pp. 64, et seq.

[3] *Astronomische Untersuchungen*, Bessel, Vol. 1, p. 207.

[4] *Contributions Col. Univ. Obs.*, No. 10, p. 115, Jacoby, and Zurhellen, Himmelsaufnahmen, p. 62, et seq.

[5] Rayet, *Ann. de l'obs. Bordeaux*, Vol. IX, p. 64, et seq., and reference 4 also.

For photographs taken for accurate positions it is necessary that this tilting should be avoided as far as possible and its effects accurately determined.

Olsson[1] and Schlesinger[2] have described experimental methods of determining the tilt. By a test with the latter method, Schlesinger found that the parallax plates were tilted decidedly. Assuming that the tilt was the same for the dates of these plates as when the tests described by Schlesinger were made, it appears by the use of the formulæ of Rayet, that an error of $\pm 0''.03$ due to the tilt, may easily occur in the case of stars unfavorably situated on the plate.

It is not possible, however, to determine these errors from this set of measures. The corrections for the two coördinates by the 6 constant method then assume the forms:

$$\begin{array}{ll} \text{for } X \text{ direction,} & aX + bY + c, \\ \text{for } Y \text{ direction,} & dX + eY + f. \end{array}$$

The equations from which the constants were derived are:

$$\begin{array}{ll} \text{for } X \text{ direction,} & aX + bY + c = X' - X, \\ \text{for } Y \text{ direction,} & dX + eY + f = Y' - Y, \end{array}$$

where the primes indicate ideal coördinates. Each star whose right ascension and declination could be found in a catalog gave one such pair of equations which were solved by the method of least squares, for the X direction and Y direction separately.

Plates π534, π778, π1263, π1270 have been used to form the catalog. No other plates had more than four catalog stars and these were all in one quadrant. On π778 and π1263 there are 6 available stars, Nos. 7, 19, 29, 39, 56, 57. These give a fairly good distribution in the X direction, but in the Y direction the extreme difference is less than a quarter the possible dispersion and except for 7 the distribution is nearly linear in X. On π534 and π1270 there is one more star available, 26, which very greatly improves the distribution in the Y direction. The scale value constant is, consequently, better determined in the X than in the Y direction and the difference in reliability is much more marked on π778 and π1263 than on π534 and π1270. (See weights below.) The scale value in Y for π778 and π1263 in addition to its evident discordance turns out to have a probable error nearly equal to itself and so can scarcely be said to be determined by the solution. Probably better values of the declinations of the stars could be derived from these plates by using such a scale constant as 0.0018.

---

[1] *Astr. Nach.*, Bd. 146, No. 5137.

[2] Photo. Determ., pp. 5, 6.

PLATE CONSTANTS.

Plate.	Direction.	Scale $\times 10^2$.	Weight.	Orientation $\times 10^2$.	Weight.	Zero.	Weight.	Probable Error of One Equation.
π534	X	+.18438	377	+1.69588	74	+1.120	2.7	$\pm''.829$
π534	Y	+.18613	74	−1.62895	377	+0.257	2.7	$\pm$ .544
π778	X	+.18484	284	+1.64126	39	+1.576	2.4	$\pm$ .843
π778	Y	+.10357	39	−1.57245	284	+0.352	2.4	$\pm$ .538
π1263	X	+.18538	283	+1.68617	39	+1.557	2.4	$\pm$ .940
π1263	Y	+.08984	39	−1.61145	283	+0.330	2.4	$\pm$ .543
π1270	X	+.17416	374	+1.65208	74	+1.520	2.7	$\pm$ .848
π1270	Y	+.17834	74	−1.58515	374	+0.471	2.7	$\pm$ .521

Control $[v] = 0$ and $[vv] = [nn \cdot 3]$.

These constants were used to reduce the measured coördinates of each star for each plate to the ideal coördinates of Table V, *i. e.*,

$$X + aX + bY + c = X',$$
$$Y + dX + eY + f = Y'.$$

TABLE V.—IDEAL COÖRDINATES.

Unit = 1″.

Catalog Number.	Plate Number.	Plate #534.		Catalog Number.	Plate Number.	Plate #778.	
		X'	Y'			X'	Y'
		″	″			″	″
7	6	−1035.133	+ 317.566	1	1	−1154.791	−460.228
8	7	− 971.081	− 392.980	2	3_1	−1148.081	+322.651
9	8_1	− 847.092	− 119.667	3	2	−1148.352	+ 7.014
10	8_2	− 842.861	− 126.709	4	4_1	−1143.534	+812.999
11	9_2	− 759.455	− 471.970	5	4_2	−1140.770	+837.172
12	9_1	− 731.349	− 442.431	6	3_2	−1137.106	+306.622
14	11	− 610.473	+ 42.102	7	6	−1037.624	+315.477
15	12	− 599.227	+ 727.456	8	7	− 973.861	−394.556
16	14	− 561.480	− 455.376	9	8_1	− 849.807	−121.442
18	74	− 477.916	− 564.602	12	9_1	− 734.128	−444.018
19	15	− 472.910	− 662.855	13	10	− 689.951	+812.099
20	43	− 469.858	− 732.824	14	11	− 613.036	+ 40.132
21	16	− 456.678	+ 115.296	15	12	− 601.705	+724.970
22	42	− 439.931	+ 710.908	16	14	− 564.196	−457.032
23	17	− 334.758	+ 565.952	17	13	− 501.211	+883.578
24	18_2	− 301.941	+ 53.314	19	15	− 475.625	−664.282
25	18_1	− 276.444	+ 94.418	20	43	− 472.671	−734.300
26	44	− 252.756	− 900.700	22	42	− 442.430	+708.434
28	55	− 115.413	−1191.546	23	17	− 337.174	+563.515
29	20	− 111.173	− 299.761	25	18_1	− 278.904	+ 92.376
30	49	− 71.728	+ 566.908	27	19	− 214.302	+932.647
31	48	+ 16.774	+ 402.684	29	20	− 113.786	−301.590
33	21	+ 32.031	+ 687.171	33	21	+ 29.722	+684.638
34	47	+ 86.842	+ 329.376	35	23	+ 181.912	+788.047
35	23	+ 184.366	+ 790.695	36	22	+ 193.121	+706.732
38	71	+ 308.158	− 392.709	37	40	+ 215.179	+932.911
39	24	+ 362.732	− 464.024	39	24	+ 359.990	−465.787
40	56	+ 365.442	− 924.693	41	26	+ 450.596	− 35.801
43	27	+ 516.518	− 360.758	42	25	+ 451.922	−176.348
44	28	+ 569.990	+ 100.940	43	27	+ 513.956	−362.663
45	29	+ 605.309	+ 726.898	44	28	+ 567.598	+ 98.703
46	30	+ 634.723	− 629.675	45	29	+ 602.950	+724.201
47	31	+ 689.117	+ 65.168	46	30	+ 632.167	−631.448
48	57	+ 781.337	− 526.802	47	31	+ 686.463	+ 62.961
49	33	+ 789.224	+ 737.228	49	33	+ 786.750	+734.521
50	32	+ 793.172	+ 257.746	51	34	+ 857.779	+949.883
52	62	+ 897.322	− 111.819	53	35	+ 968.880	+574.037
53	35	+ 971.088	+ 576.790	54	36	+1071.489	− 2.618
54	36	+1073.692	− 0.260	55	37	+1097.342	+361.282
55	37	+1099.614	+ 363.867	56	39	+1191.494	−455.650
56	39	+1193.740	− 453.569	57	38	+1198.784	−507.196
57	38	+1201.520	− 505.295				
61^1 Cygni		− 7.832	+ 7.565	61^1 Cygni		− 7.390	+ 7.716
61^2 Cygni		+ 10.040	− 7.050	61^2 Cygni		+ 10.543	− 7.012

TABLE V.—IDEAL COÖRDINATES.—*Concluded.*

Catalog Number.	Plate Number.	Plate #1263.	
		X″	Y″
1	1	−1158″.878	− 463″.313
2	3_1	−1152.259	+ 319.333
3	2	−1152.535	+ 3.836
4	4_1	−1147.556	+ 809.635
5	4_2	−1144.792	+ 833.883
7	6	−1041.884	+ 312.235
8	7	− 978.064	− 397.715
9	8_1	− 854.010	− 124.608
12	9_1	− 738.326	− 447.220
13	10	− 694.026	+ 808.631
14	11	− 617.241	+ 36.856
15	12	− 605.818	+ 721.571
16	14	− 568.372	− 460.195
17	13	− 505.224	+ 880.137
19	15	− 479.953	− 667.527
20	43	− 476.866	− 737.472
21	16	− 463.489	+ 109.765
22	42	− 446.571	+ 704.970
23	17	− 341.356	− 560.099
25	18_1	− 283.198	+ 89.006
27	19	− 218.363	+ 929.107
29	20	− 118.069	− 304.845
32	41	+ 18.641	+ 865.252
33	21	+ 25.300	+ 681.193
35	23	+ 177.717	+ 784.556
37	40	+ 211.177	+ 929.357
39	24	+ 355.823	− 469.074
41	26	+ 446.335	− 39.180
42	25	+ 447.575	− 179.802
43	27	+ 509.681	− 365.919
44	28	+ 563.212	+ 95.387
45	29	+ 598.730	+ 720.758
46	30	+ 627.790	− 634.695
47	31	+ 682.232	+ 59.598
49	33	+ 782.582	+ 731.039
50	32	+ 786.673	+ 251.848
51	34	+ 853.506	+ 946.319
53	35	+ 964.431	+ 570.461
54	36	+1067.050	− 5.977
55	37	+1092.940	+ 357.832
56	39	+1186.964	− 458.896
57	38	+1194.681	− 510.498
61^1 Cygni		− 7.402	+ 7.787
61^2 Cygni		+ 10.515	− 7.126

Catalog Number.	Plate Number.	Plate #1270.	
		X″	Y″
1	1	−1158″.793	−463″.951
2	3_1	−1152.278	+319.585
3	2	−1152.450	+ 3.715
4	4_1	−1147.762	+810.171
7	6	−1041.958	+312.391
8	7	− 977.851	−398.195
9	8_1	− 853.860	−124.732
12	9_1	− 738.131	−447.608
13	10	− 694.225	+809.303
14	11	− 617.286	+ 36.840
15	12	− 606.084	+722.227
16	14	− 568.233	−460.587
17	13	− 505.595	+880.865
19	15	− 479.788	−668.009
20	43	− 476.692	−738.069
23	·17	− 341.524	+560.642
26	44	− 259.576	−905.927
27	19	− 218.879	+930.050
29	20	− 118.021	−305.015
32	41	+ 18.231	+866.074
35	23	+ 177.332	+785.367
36	22	+ 188.755	+703.916
37	40	+ 210.742	+930.376
39	24	+ 355.832	−469.233
41	26	+ 446.209	− 38.964
43	27	+ 509.681	−366.063
45	29	+ 598.298	+721.524
46	30	+ 627.864	−635.016
47	31	+ 682.069	+ 59.908
49	33	+ 782.234	+731.943
50	32	+ 786.386	+252.354
51	34	+ 853.026	+947.416
53	35	+ 963.930	+571.465
54	36	+1066.838	− 5.543
55	37	+1092.693	+358.490
56	39	+1186.878	−458.806
57	38	+1194.722	−510.527
61^1 Cygni		− 7.423	+ 7.983
61^2 Cygni		+ 10.463	− 7.040

5. **Right Ascensions and Declinations Derived from Ideal Coördinates.**—The positions in Table VI result from reducing ideal coördinates to differences in right ascension and declination by the series formulæ and then adding these differences to the right ascension and declination of the central point.[1] The series formulæ are:[2]

$$\begin{aligned} \Delta\alpha &= X' \sec\delta + A_1(X' \sec\delta)Y' & A_1 &= \text{tang}\,\delta \sin 1'', \\ &\quad + A_2(X' \sec\delta)Y'^2 & A_2 &= \text{tang}^2\,\delta \sin^2 1'', \\ &\quad \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot, \\ \Delta\delta &= Y' + D_1(X' \sec\delta)^2 & D_1 &= -\tfrac{1}{4} \sin 2\delta(15)^2 \sin 1'', \\ &\quad + D_2(X' \sec\delta)^2 Y' & D_2 &= -\tfrac{1}{2}(15)^2 \sin^2 1'', \\ &\quad + D_3(Y'^3) & D_3 &= -\tfrac{1}{3} \sin^2 1''. \\ &\quad \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot, \end{aligned}$$

Column 1 of the catalog gives the current number and column 2, the number actually written on the plates when they were measured and used to designate the star throughout the computing. Column 3 gives the photographic magnitude, column 4, the photo-visual magnitude and column 5, the color-index of the stars. These were determined from photographs taken with the 6-inch camera, the 24-inch reflector and the 40-inch refractor at the Yerkes Observatory by Professor J. A. Parkhurst, who kindly furnished the results from the Yerkes photometric program, in advance of publication. Column 6 gives the right ascension as derived from the mean of the four plates. Residuals, in the sense plate minus mean, are given in columns 7, 8, 9, 10, in units of the third decimal place. Therefore, by adding this residual to the mean, the values for the individual plates may be recovered. Column 11 gives the declination as derived from the mean of plates $\pi 534$ and $\pi 1270$ alone, because of the great uncertainty in the scale value for the Y direction of the other two plates.[3] The residuals of columns 12, 13, 14, 15 are in units of the second decimal place and are given in the sense described above. Column 16 gives the number in the *Potsdam Photographische Himmelskarte*, Vol.

---

[1] See p. 25.

[2] See reference 2, p. 24.

[3] See table of scale constants, p. 28.

III, Plate 1071; column 17, the number in Davis' Catalog, pp. 110–112 of No. 13 of the *Contributions from the Observatory of Columbia University;* column 18, the number in the *Astronomische Gesellschaft Catalog* (Lund); column 19, the number from the *Bonn Durchmusterung.*

The positions of the different stars are by no means equally reliable. Some images were marked "poor" when measured. There is also a difference in precision due to the effect of the unknown tilt of the plate and varying for different parts of the plate.[1] The last decimal place of the values given both in right ascension and declination is merely a figure of computation.

---

[1] See p. 27.

TABLE VI.—CATALOG. *Equinox* 1900.0.

Current Number.	Plate Number.	Magnitude.		Color-Index.	Right Ascension 1912.8.	Residual.				Declination 1912.7.	Residual.				Identification.			
		Photographic.	Photovisual.			π534.	π778.	π1263.	π1270.		π534.	π778.	π1263.	π1270.	Potsdam.	Davis.	A. G. Lund.	B.D.
					h m s													
1	1	11.64	—	—	21 0 52.130	—	−14	+3	+11	38° 8′ 16.45″	—	+47	+62	0	372			
2	3_1	11.09	—	—	52.398	—	−5	+3	+2	21 20.00	—	−20	−27	0	370			
3	2	11.16	—	—	52.496	—	−8	0	+8	16 4.14	—	+3	+10	—	371			
4	4_1	11.84	—	—	52.605	—	−8	+12	−4	29 30.59	—	−43	−56	0				
5	4_2	—	—	—	52.834	—	−11	+10	—	29 54.—	—	+34	+29	—	374			
6	3_2	—	—	—	53.332	—	0	—	—	21 3.—	—	+82	—	—				
7	6	9.52	9.33	+0.19	1^m 1.784	−2	+2	+3	−2	21 13.26	0	−17	−17	+1	385	14	9871	+38° 4336
8	7	10.30	10.34	−0.04	7.444	+7	−13	−6	+13	9 22.96	+2	+36	+44	−2	393	16		+37° 4171
9	8_1	11.14	10.80	+0.34	17.884	+5	−10	−4	+10	13 56.78	−7	+8	+16	+6	401			
10	8_2	—	—	—	18.249	0	—	—	—	13 49.68	0	—	—	—				
11	9_2	—	—	—	25.413	0	—	—	—	8 4.68	0	—	—	—				
12	9_1	11.19	10.94	+0.25	27.781	+7	−13	−6	+12	8 34.31	−1	+33	+37	+1	408			
13	10	12.12	11.51	+0.61	31.236	—	−5	+11	−5	29 31.33	—	−47	−69	0				
14	11	11.20	11.26	−0.06	37.940	−1	−3	+3	0	16 39.10	+4	−1	−3	−3	414			
15	12	12.12	10.49	+1.63	38.764	−4	+1	+13	−8	28 4.50	+1	−55	−70	−2	415			
16	14	11.34	11.16	+0.18	42.186	+4	−11	−2	+11	8 21.76	+1	+28	+37	0				
17	13	11.15	11.00	+0.15	47.299	—	−4	+18	−13	30 43.33	—	−56	−75	0	427			
18	74	13.51	12.79	+0.72	49.289	0	—	—	—	6 32.72	0	—	—	—				
19	15	9.67	8.82	+0.85	49.720	+9	−5	−9	+6	4 54.50	−3	+47	+48	+2	429	21	9886	+37° 4173
20	43	11.40	11.31	+0.09	49.989	+9	−13	−6	+10	3 44.48	+3	+48	+56	−2	431			
21	16	12.49	12.24	+0.25	50.988	0	—	+1	—	17 52.65	0	—	−36	—	432			
22	42	—	12.04	—	52.331	−5	−2	+8	—	27 48.28	0	−55	−76	—				
23	17	11.22	11.26	−0.04	2^m 1.304	−8	+3	+10	−4	25 23.44	+5	−46	−63	−6	440			
24	18_2	—	—	—	4.139	0	—	—	—	16 50.89	0	—	—	—	442			
25	18_1	10.42	10.76	−0.34	6.305	−4	+3	+2	—	17 32.02	0	−11	−23	—	443	24		+38° 4342
26	44	10.32	9.22	+1.10	8.396	−2	—	—	+1	0 56.92	+2	—	—	−1	445		9890	+37° 4174
27	19	12.18	11.41	+0.72	11.734	—	+2	+20	−23	31 32.91	—	−68	−96	0	449			
28	55	9.96	—	—	20.027	0	—	—	—	37 56 6.19	0	—	—	—	457	27	. . . .	+37° 4175
29	20	10.28	10.33	−0.05	20.344	+9	+4	+4	−19	38 10 57.94	+3	+18	+13	−2	456		9893	+38° 4345
30	49	—	11.90	—	23.678	0	—	—	—	24 24.65	0	—	—	—				
61^1 Cygni		—	—	—	29.488	−371	−117	+244	+244	16 8.13	−281	−73	+260	+281	460	25	9891	+38° 4343
61^2 Cygni		—	—	—	31.008	−374	−115	+246	+242	15 53.31	−261	−64	+250	+261	461	26		+38° 4344

TABLE VI.—CATALOG—*Concluded.*

Current Number.	Plate Number.	Magnitude.		Color-Index.	Right Ascension 1912.8.	Residual.				Declination 1912.7.	Residual.				Identification.			
		Photographic.	Photovisual.			π534.	π778.	π1263.	π1270.		π534.	π778.	π1263.	π1270.	Potsdam.	Davis.	A. G. Lund.	B.D.
					h m s					° ′ ″								
31	48	10.88	10.85	+0.03	21 2 31.208	0	—	—	—	38 22 40.43	0	—	—	—	465			
32	41	10.11	10.21	−0.11	31.932	—	—	+17	−17	30 29.03	—	—	−84	0	468	29		+38° 4348
33	21	11.48	11.12	+0.36	32.517	−8	+11	−2	—	27 24.92	0	−61	−79	—	469			
34	47	10.20	9.69	+0.51	37.165	0	—	—	—	21 27.11	0	—	—	—	472	30		+38° 4349
35	23	10.05	10.20	−0.15	45.484	0	+7	+13	−19	29 8.32	+5	−66	−89	−6	477	33		+38° 4350
36	22	13.0—	11.17	+1.8—	46.436	—	+4	—	−3	27 46.80	—	−46	—	0				
37	40	11.03	11.04	−0.01	48.337	—	−3	+19	−17	31 33.24	—	−75	−104	0	480			
38	71	—	—	—	55.885	0	—	—	—	9 25.23	0	—	—	—	486			
39	24	9.69	8.46	+1.23	3^m 0.520	+7	−9	0	−2	8 13.48	0	+17	+15	+1	489	35	9900	+37° 4179
40	56	10.35	10.25	+0.10	0.702	0	—	—	—	0 32.81	0	—	—	—				
41	26	10.18	10.24	−0.06	8.251	—	+2	+3	−6	15 23.62	—	−13	−24	0	497	36		+38° 4351
42	25	11.59	11.76	−0.17	8.342	—	+3	−3	—	13 2.—	—	+94	+76	—	498			
43	27	—	10.31	—	13.578	+1	0	0	−1	9 56.44	+4	+7	+9	−4				
44	28	—	11.78	—	18.204	−5	+7	−2	—	17 38.07	0	−30	−36	—				
45	29	11.24	11.12	+0.12	21.326	−4	+11	+15	−21	28 3.86	+8	−68	−86	−7				
46	30	10.20	10.28	−0.08	23.544	+3	+2	−5	+2	5 27.26	+5	+22	+24	−6	512	41		+37° 4183
47	31	11.11	9.87	+1.24	28.304	+6	+6	0	−13	17 2.00	+1	−26	−35	−2	514			+38° 4354
48	57	—	—	—	35.992	0	—	—	—	7 9.79	0	—	—	—	520			
49	33	10.33	9.51	+0.82	36.985	−1	+4	+13	−15	28 13.74	+3	−74	−94	−2	522			+38° 4355
50	32	13.17	11.99	+1.18	37.207	−10	—	+16	−7	20 14.21	+8	—	+39	−8				
51	34	10.87	10.90	−0.03	43.084	—	+14	+13	−27	31 48.96	—	−82	−111	0	529			
52	62	—	—	—	45.648	0	—	—	—	14 4.39	0	—	—	—	531			
53	35	12.03	11.13	+0.90	52.422	−3	+25	+10	−32	25 32.68	+4	−77	−107	−4				
54	36	10.38	10.92	−0.54	4^m 0.960	−11	+18	+4	−13	15 55.26	+3	−39	−47	−2	547	46		+38° 4358
55	37	—	10.20	—	3.287	−7	+17	+5	−15	21 59.22	+6	−43	−74	−6	549			+38° 4359
56	39	10.52	10.97	−0.45	10.974	−7	+19	−2	−9	8 21.48	−1	−15	−12	0	558		9915	+37° 4188
57	38	7.85	7.90	−0.05	11.604	+3	−13	−1	+6	7 29.72	−1	+3	+1	0	559	48	9916	+37° 4189

V. THE PARALLAX OF 61 CYGNI.

1. **Historical Notes.**—To find 61 Cygni with unaided sight, an observer must choose a time when the constellation is above the horizon mists and when the sky is not only clear but moonless. Even then it may be picked out only with care from among the neighboring faint stars against the faintly luminous background of the Milky Way. Yet in spite of its apparent insignificance, there is, for this double star, a long history of observation. It has been the object of frequent studies to determine its parallax, its proper motion and its characteristics as a binary system and in 1911 its name was given to a "moving cluster."[1]

Bradley at Greenwich[2] on September 25, 1753, was the first to record that the star was double. In 1792, Piazzi, when comparing his own observations with Bradley's, noted that the large proper motion indicated that this star was relatively near the earth.[3] This may be regarded as the beginning of the extended observations on its proper motion and to hold the germ of the many later determinations of its parallax. Observations of 61 Cygni were begun by Herschel[4] in September, 1780. He believed, at that time, that the two components of double stars were widely separated in space and began systematic cataloging of double stars and observations of the relative positions of the components in the hope that they might ultimately lead to the determination of annual parallax.[5]

In 1812 Arago and Mathieu determined at Paris[6] that the radius of the earth's orbit as seen from 61 Cygni subtends an angle less than 0″.5. Peters[1] using the data given by Arago derives a value $\pi = +0''.55$. This result is so near to later accepted values that it is a matter for real regret that no full description is available of the method by which it was obtained. This is specially true since Struve found from his investigations at Dorpat[2] between 1818 and 1821 that the quantities concerned in finding parallax were not within the measuring powers of the best existing instruments.

---

[1] *Astronomical Journal*, Vol. 27, p. 33 and 67, B. Boss.

[2] Observed Transits of Sun, Planets and Fixed Stars over the Meridian, p. 129, Bradley.

[3] Specola Astronomica di Palermo, lib. VI, p. 10, note.

[4] *Philosophical Transactions*, Vol. 72, p. 138.

[5] *Phil. Trans.*, Vol. 72, p. 112.

[6] Annuaire, Bureau des Longitudes, 1834, p. 282. Note.

Peters[3] also publishes a value $\pi^1 = +0''.47 \pm .51$ derived by him from the observations of von Lindenau at Seeburg in 1812–14.[4] Von Lindenau himself had stated that no parallax was indicated by the observations and the relation of the probable error to the value itself as given by Peters leads to no confidence in that result as significant.

Another unfruitful effort to find the parallax of 61 Cygni was made by Bessel[5] in 1815–16. He compared the position of the star with 6 others and was led to the values $\pi = -0''.76$ and $\pi = -1''.32$ from two series of observations.

In 1812, Bessel[6] made a speculative determination of the parallax of 61 Cygni from his measures of the distance between the two components. He assumed 400 years as the period of revolution and that the mass of the system equals the mass of the sun and derived the value $\pi = +0''.46$.

When, in 1837, Bessel decided to make a new attack on the parallax problem with the aid of the heliometer which Fraunhofer[7] had constructed, he again chose 61 Cygni as the object for observation. The heliometer, or "divided object-glass micrometer," was first described by Dollond[1] in 1753. The Königsberg heliometer permitted more accurate measures of angular distances than had been possible before. It was, then, partly to the perfection of his instrumental equipment that Bessel's success in determining stellar parallax is due.

---

[1] Recherches Sur la Parallaxe des Étoiles Fixes. Mémoirs de L'Academie des Sciences, St. Petersburg, VI series, Vol. VII, p. 48.

[2] Beobachtungen der Universitäts Sternwarte, Dorpat, Vol. 3.

[3] Recherches Sur la Parallaxe des Étoiles Fixes. Mémoirs de L'Academie des Sciences, St. Petersburg, VI series, Vol. VII, p. 48.

[4] Table l'Ephemeride de Berlin pour 1818, p. 247.

[5] *Astr. Nach.*, Vol. 16, p. 71, also *Königsberger Beobachtungen*, Abth. II, p. VIII; Abth. III, p. IX.

[6] *Zach's Monatliche Correspondenz*, Vol. XXVI, 1812, p. 162.

[7] *Astr. Nach.*, No. 189.

Bessel[2] gives very clearly his reasons for choosing 61 Cygni as the first object for his investigation. The large proper motion suggested nearness and hence a relatively large, and possibly measurable, parallax. The star was in position for observation most of the year and there were many stars near it from which to select comparison stars. Bessel also was convinced that the image of the comparison star formed by the moving half of the object-glass could be brought to the point midway between the two components of a double star more accurately than it could be brought into coincidence with a single star image.

The values for the parallax of 61 Cygni resulting from Bessel's observations may be found in Table VII. They constitute the first real knowledge of the scale of our stellar universe, and his result is not greatly modified by the latest values.[3] The binary system of 61 Cygni is about 600,000 astronomical units, or 10 light years, from the solar system. Only 6 stars are known to be nearer.

Of the many determinations of the parallax of this star, since Bessel, some have been made like his in reference to the point midway between 61^1 and 61^2 Cygni, some for the individual stars. The reasons enumerated by Bessel for his choice of 61 Cygni are now supplemented by two others that have influenced succeeding investigators. The fame of the star as the first for which the annual parallax was determined lends a great weight, in itself, to making the decision to include it on any parallax program. More important, however, is the fact that it gives a standard for the comparison of the excellence of each new series of parallax determinations. This was the reason that Pritchard employed the star for his first essay in the photographic determination of parallax. He writes[1] that the star "was selected on account of the unusually numerous examinations which have been applied to it by successive astronomers from the time of Bessel to the present date; my object being not so much to effect a redetermination of the parallax of this historical star as to obtain the means of comparing the photographic method with those other methods of micrometrical measurement heretofore directly applied to this end."

---

[1] *Phil. Trans.*, Vol. XLVIII, Part II, p. 551, An explanation of an instrument for measuring small angles.

[2] *Astr. Nach.*, Vol. 16, p. 70.

[3] See Reference 11 in the list following Table VII.

In No. 13 of the *Contributions from the Observatory of Columbia University* the parallaxes of 61^1 and 61^2 Cygni were determined by Davis from the Rutherfurd photographs. His Table XXIII gives the particulars of various determinations of the parallaxes of the separate components. No determinations derived from observations on the point midway between the two components were included. The list was published in 1898.

Table VII, p. 39 includes determinations from the mean point and determinations since 1898. The general form of Davis' table has been followed to facilitate the use of the two tables as a single list. Table VII gives the values in the chronological order of the observations without subdivision.

In the column headed "Parallax," π is used to indicate values of the parallax of the system regarded as a unit, π^1 and π^2 are used to indicate the values for 61^1 and 61^2 respectively.

The column headed "References" refers by number to authorities given in the list following the Table.

---

[1] *Monthly Notices*, Vol. 47, p. 87 (1887).

TABLE VII.—VARIOUS VALUES OF THE PARALLAX OF 61 CYGNI.

Method.	Comparison Stars.	Parallax.	Probable Error.	Authority.	Ref.	Year of Publication.	Year of Observation.
Königsberg, Heliometer	*a*	$\pi = +0''.3690$	$\pm 0''.0191$	Bessel	1	1838	1837–38
	b	$\pi =$ .2605	.0188				
	a and *b*	$\pi =$ .3136	.0136				
Königsberg, Heliometer	*a*	$\pi =$ .3584	.0131	Bessel	2	1840	1838–40
	b	$\pi =$ .3289	.0140				
	a and *b*	$\pi =$ .3483	.0095				
Königsberg, Heliometer	*a*	$\pi =$ .3954	.0138	Peters' Bessel	3	1849	1837–40
	b	$\pi =$ .3424	.0140				
	a and *b*	$\pi =$ .3744	.0099				
	a and *b*	$\pi =$ .3602 (Definitive)	.0121				
Königsberg, Heliometer	*a* and *b*	$\pi =$ .351	.020	Auwers' Bessel	4	1868	1837–38
	a and *b*	$\pi =$ .530	.028				1838–40
Poulkowa, Vertical Circle δ	Absolute	$\pi^1 =$ .43		Glasenapp's Peters	5	1881	1842–43
Poulkowa, Vertical Circle δ	Absolute	$\pi^1 =$ .544		Chandler's Peters	6	1893	1842–43
Poulkowa, Vertical Circle δ	Absolute	$\pi^1 =$ .413	.084	Smirnow's Peters	7	1905	1842–43

TABLE VII.—VARIOUS VALUES OF THE PARALLAX OF 61 CYGNI.—*Continued.*

Method.	Comparison Stars.	Parallax.	Probable Error.	Authority.	Ref.	Year of Publication.	Year of Observation.
Radcliffe, Heliometer	*c*	$\pi = +0''.360$	$\pm 0''.025$	Johnson	8	1853	1852–53
	d	$\pi = .386$	.027				
	c and *d*	$\pi = .430$	.026				
		$\pi = .392$ (Mean)	.015				
	c	$\pi = .392$	.030				
	d	$\pi = .389$	.026				
	c and *d*	$\pi = .427$	.016				
		$\pi = .402$ (Mean)	.016				
Radcliffe, Heliometer	*c* and *d*	$\pi = .511$	.026	Auwers' Johnson	9	1863	1852–53
	c and *d*	$\pi = .177$	.033				
Königsberg, Heliometer	38° 4355	$\pi = .5588$ (Relative)	.0161	Auwers	10	1863	1860–62
	37° 4170	$\pi = .5638$ (Absolute)	.0162				
Helsingfors, Photography (Donner)	4 stars	$\pi^1 = .294$		Kapteyn	11	1902	1891–92
		$\pi^2 = .348$					
		$\pi = .321$	.035				
		$\pi^1 = .304$		Kapteyn (Veenstra)			
		$\pi^2 = .366$					
		$\pi = .335$					
		$\pi = .326$ (Mean)	.035				
Göttingen, Heliometer	37° 4131	$\pi^1 = .332$	.093	Peter's Schur	12	1903	1897
	38° 4405	$\pi^2 = .278$	.013				
		$\pi^1 = .381$	.084				
		$\pi^2 = .299$	.027				

TABLE VII.—VARIOUS VALUES OF THE PARALLAX OF 61 CYGNI.—*Continued.*

Method.	Comparison Stars.	Parallax.	Probable Error.	Authority.	Ref.	Year of Publication.	Year of Observation.
Poulkowa, Photography	59 stars	π^1 = +0.″31	±0.″03	Kostinsky	13	1905	1896–98
	30 stars	π^1 = .47	.03				
		π^1 = .39 (Mean)	.02				
	59 stars	π^2 = .38	.03				
	30 stars	π^2 = .38	.03				
		π^2 = .38 (Mean)	.02				
Heidelberg,	Lal 40652	π^1 = .342	.061	Jost	14	1906	1899–1900
Meridian Circle	W_2 20^h 1762	π^1 = .342	.060				
$\Delta\alpha$	Lal 41131	π^1 = .262	.049				
	D'Agelet 5760	π^1 = .333	.036				
		π^1 = .320 (Mean)	.029				
Cambridge, Photography	10 stars	π^1 = .406	.024	Russell	15	1910	1904–5
		π^2 = .361	.021				
		π = .384	.021				
Yale, Heliometer	1st pair of stars	π^1 = .339	.010	Chase	16	1907	1904–6
		π^2 = .295	.011				
	2d pair of stars	π^1 = .279	.010				
		π^2 = .281	.013				
		π = .291 (Mean)	.005				
Heidelberg,	38° 4325	π^1 = .24	.05	Abetti	17	1908	1906–7
Meridian Circle	37° 4189	π^2 = .22	.05				
$\Delta\alpha$							
Cracow,	38° 4323	π^1 = .276	.079	Jewdokimov.	18	1912	1907–8
Meridian Circle	37° 4189	π^1 = .291	.084				
		π^1 = .284 (Mean)	.071				

TABLE VII.—VARIOUS VALUES OF THE PARALLAX OF 61 CYGNI.—*Concluded.*

Method.	Comparison Stars.	Parallax.	Probable Error.	Authority.	Ref.	Year of Publication.	Year of Observation.
Upsala, Photography	4 stars	$\pi^1 = +0''.3431$	$\pm 0''.0085$	Bergstrand	19	1903	1899–1903
		$\pi^1 = .3404$	.0176				
		$\pi^1 = .3426$ (Mean)	.0077				
		$\pi^1 = .2804$	.0119				
		$\pi^1 = .3192$	.0178				
		$\pi^1 = .2923$ (Mean)	.0091				
		$\pi = .2926$	.0073				
Upsala, Photography	4 stars	$\pi^1 = .375$		Bohlin's Bergstrand	20	1908	1899–1903
		$\pi^1 = .337$					
		$\pi^1 = .363$	.010				
Leipzig, Heliometer	37° 4131	$\pi^1 = .278$	.023	Peter	21	1903	1901–2
		$\pi^2 = .291$	.014				
	38° 4405	$\pi^1 = .254$	.026				
		$\pi^2 = .290$	.012				
Königsberg $\Delta\delta$	7 stars	$\pi^1 = .265$	.024	Struve	22	1914	1902–4
		$\pi^1 = .327$	.015				
		$\pi = .309$	.013				
Yerkes, Photography	4 stars	$\pi^1 = .267$	.011	Hopkins	23	1915	1911–13
		$\pi^2 = .277$	.012				
	8 stars	$\pi^1 = .256$	.007				
		$\pi^2 = .251$	.012				
Yerkes, Photography	6 stars	$\pi^1 = .267$	.004	Slocum	24	1914	1911–13
		$\pi^2 = .277$	.006				
Sproul, Photography	16 stars	$\pi = .301$	.010	Miller	25	1914	1912–13

3. **Remarks.**—The writer believes that the series of values in the two tables, No. XXIII, Publ. 13 and No. VII of this paper, give a truer notion of the present state of knowledge as to the parallax of 61 Cygni than any combination of values. If a statistical average seems necessary the *mode* would be a more characteristic value than the weighted mean, entirely omitting any values regarded by the investigator as untrustworthy.

One criterion of reliability is the inter-agreement of values derived from the same body of evidence. In this respect the results from the Yerkes parallax photographs leave little to be desired. The results announced by Slocum from his measures of 14 plates using 6 comparison stars, and the two sets of results on p. 27 derived by the writer from 6 plates using 4 and 8 comparison stars, respectively, agree within the limits of the probable errors.

The Yerkes results discredit any assumption that the value of $\pi^1 - \pi^2$ is other than zero. We may consider then that this "more extended series of photographic measures" which Davis[1] thought desirable has answered the question of the possible difference of parallax between the two components in the negative.

REFERENCES FOR TABLE VII.

1. Bessel. Astronomische Nachrichten, Vol. 16, pp. 65–96, No. 365–66; Abhandlungen von Bessel (Engelmann), Vol. II, Pt. IV, No. 83.
2. Bessel. Astronomische Nachrichten, Vol. 17, pp. 257–276, No. 401–402; see (3) below; Abhandlungen—see (1) above.

   The measures (only) are given in Königsberger Astronomische Beobachtungen, Vol. 21–24. A part of this series of observations is by Schlüter.

   Bessel gives his results, as printed in Table VII plus a term with a very small coefficient of temperature (*k*).
3. C. A. F. Peters. Bulletin de l'Academie des Sciences de St. Petersburg, Vol. VIII, No. 4. Ueber Bessels Bestimmung der Parallaxe von 61 Cygni. On page 41 is a list of printer's errors in Astr. Nach. 401 (Bessel's observations)—see (2) above.

   The first three values (Table VII) are derived by a new valuation of *k*—see (2) above. The fourth value is weighted, relative to distance of comparison stars.

---

[1] Publ. No. 13, p. 158.

4. Auwers. Abhandlungen de königl. Akademie der Wissenschaften zu Berlin, pp. 113, 114, Untersuchungen über die Beobachtungen von Bessel und Schlüter am Königsberger Heliometer zur Bestimmung der Parallaxe von 61 Cygni.

*5. Glasenapp. Memoirs de l'Academie Imperiale des Sciences de St. Petersburg, VI Series, Vol. V.

6. Chandler. Astronomical Journal, Vol. XIII, p. 34, No. 293. Taking into consideration the variation in latitude Chandler reduces Peters' observations, remarking "this result is perfectly in line with the most trustworthy micrometrical determinations; Struve, $\pi = +0''.511$ and Auwers, $\pi = +0''.564$."

*7. Smirnow. St. Petersburg. Imperial Russian Observatory, Vol. 4 (1905), pp. 193–208. " Parallaxes des étoiles α Cygne et 61^1 Cygne d'après les observations de Peters, en tenant compte de la variation des latitudes; en russe."

8. Johnson. Astronomical and Meteorological Observations made at the Radcliffe Observatory in the year 1853, Vol. XIV, p. XXXIX.

From p. XXXV, " there appears to be a small probability in favor of the temperature correction." This correction was applied in deriving the last three values (Table VII).

9. Auwers. Astronomische Nachrichten, Vol. 59, No. 1411–16, pp. 289–384. Parallaxen Bestimmungen mit dem Königsberger Heliometer. Results from reduction of Johnson's observations, p. 380. The two values quoted are for the first 11 months and the last 6 months of observations.

10. Auwers. Same as (9) above. Result, p. 333. Auwers also gives on p. 366, $\pi = +0''.5508 \pm .0141$, as the most probable mean of his value and that of O. Struve. (See Contr. Obs. Col. Univ., No. 13, Table XXIII.)

11. Kapteyn. Publications of the Astronomical Laboratory of Groningen, No. 10, pp. 48–58. The plates were taken by Donner according to Kapteyn's plan, Bulletin . . . de la Carte du Ciel, I, p. 262–64, and were measured by Kapteyn in 1893, by Veenstra in 1899. Result in reference to 10 stars is given—see Contr. Obs. Col. Univ., No. 13, Table XXIII. Kapteyn shows that the best value is found in reference to 4 stars, as in Table VII. In Groningen Publ., No. 24, (1910) Kapteyn and Weersma give, $\pi = +0''.311$ as the "adopted" value from various determinations.

12. B. Peter. Astronomische Nachrichten, Vol. 167, p. 97, No. 3895. Bestimmung der Parallaxe von 61 Cygni. Schur's observations in Vol. 150, p. 251, No. 3590. Ueber die Parallaxe eines Sterns in der Nähe von 61 Cygni. The second set of results is obtained by omitting the proper motion term from the equations.

13. Kostinsky. Publications de l'Observatoire Central Nicolas à Poulkowa, II Série, Vol. XVII. II, Untersuchungen auf dem Gebiete der Sternparallaxen, mit Hilfe der Photographie, p. 76.

14. Jost. Veröffentlichungen der Grossherzoglichen Sternwarte zu Heidel-

berg. Astronomisches Institut, Vol. IV, pp. 90–95; report and final result Vierteljahrsschrift, Vol. 41, p. 146.

15. Russell. Determinations of Stellar Parallax, Carnegie Institution of Washington Publication No. 147, p. 76. Also, Astronomical Journal, Vol. XXVI, p. 149, p. 85. Russell states, "there can be little doubt that the parallax found in the present work is too great by 0″.08 or thereabouts." Assigns brightness of the parallax star as the cause of this error.
16. Chase. Astronomical Journal, Vol. XXV, No. 17, p. 141.
17. Abetti. Astronomische Nachrichten, Vol. 178, p. 353, No. 4270.
18. Jewdokimov. Annales de l'Observatoire Astronomique de l'Université Impériale de Kharkow, Tome III, pp. 128–9. On p. 167 he finds $\pi^1 = +.311$ as mean result of various other observers.
19. Bergstrand. Astronomische Nachrichten, Vol. 167, p. 241, No. 3999. Ueber die Wirkung der atmosphärischen Dispersion auf die Bestimmung der jährlichen Parallaxen der Fixsterne. Also Nova Acta regiae societatis scientiarum, Upsaliensis, Series IV, Vol. I, No. 3. The first group of determinations was made without hour angle term in equations, the second group with that term. First result in each group is from X equations, second from Y equations. Final value given on the assumption that $\pi^1 - \pi^2 = 0$.
20. Bohlin. Astronomische Nachrichten, Vol. 177, p. 249, No. 4240. New reduction of Bergstrand. In Astr. Nach., Vol. 179, p. 367, No. 4295 Berstrand criticizes Bohlin's assumptions and results.
21. B. Peter. Same as (12) above. Reduction of his own observations using same comparison stars as Schur.
22. H. Struve. Astronomische Beobachtungen auf der Königlichen Sternwarte zu Königsberg, Abteilung 43, III. 1, p. 88. Observations with 13-inch refractor.
23. Hopkins. See pp. 21, 22, above.
24. Slocum. Report of 16th meeting of the American Astronomical Society. Popular Astronomy, Vol. XXII, p. 147.
25. Miller. Report of 17th meeting of the American Astronomical Society. Popular Astronomy, Vol. XXII, p. 634.

* These references not consulted.

ACKNOWLEDGMENTS.

To the Yerkes Observatory I owe a debt I gladly acknowledge, for permission to use my measures of the parallax photographs for this paper. To its staff I shall always be grateful for encouragement in my work, and in particular to Professor J. A. Parkhurst for the magnitudes of the stars in Table VI.

Dr. S. A. Mitchell, now of Virginia, Dr. Frederick Slocum, now of Wesleyan, and Dr. Harold Jacoby, under whose supervision the reductions have been completed at Columbia, have given me many helpful suggestions.

I wish also to thank the trustees of Smith College for granting me a year's leave of absence from my duties there and for assigning to me a non-resident fellowship.

MARY MURRAY HOPKINS.

VITA.

Mary Murray Hopkins was born in Brooklyn, New York, 1878. She prepared for college at Adelphi Academy; received the degree of A.B. from Smith College, Northampton, Massachusetts in 1899 and the degree of A.M. in 1911. Her master's essay was "The Reduction of the Right Ascensions of 21 North Polar Stars from Observations Made with the Wälker Meridian Circle at the University of Michigan by Harriet W. Bigelow."

She taught mathematics and latin in Miss Ritchey's School, Bay Ridge, 1899–1903, and in 1906 became assistant, in 1908 instructor, in 1915 assistant professor of astronomy at Smith College.

She has attended Columbia University during summer sessions in 1907, 1909, 1910, 1914 and 1915 and the winter session in 1914–1915. The summers of 1912 and 1913 were spent at the Yerkes Observatory measuring parallax photographs.